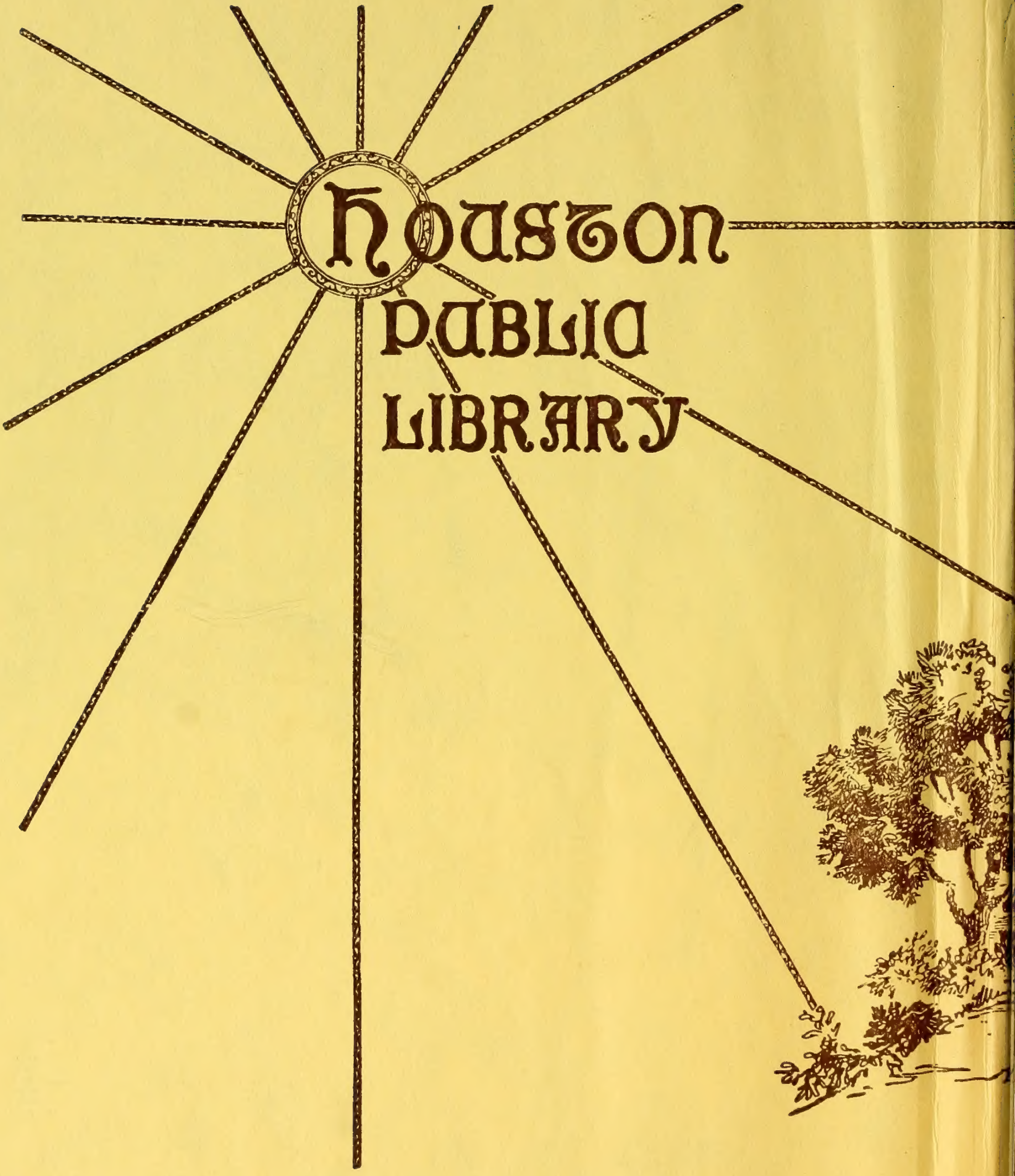
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SEPTEMBER 6, 1965

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THE WEEKLY OF ADVANCED TECHNOLOGY

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exploring and exploiting the seas

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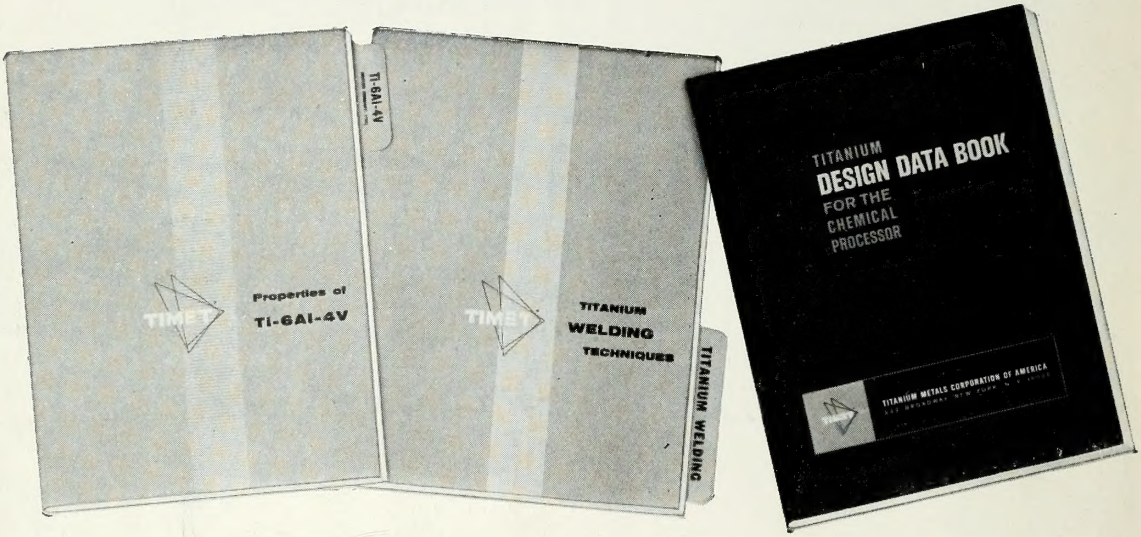
These new TIMET publications won't make you a titanium expert overnight...



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SPACESHIP

It is Deep Quest, designed to venture deep into the oceans of the world. To inner space. And already, this incredible voyage is underway, for the technologies required in deep submergence systems are now being advanced in a systematic R & D program at Lockheed.

For example, a fifth scale model of the Deep Quest pressure hull has completed verification tests at San Antonio's Southwest Research Institute. Proven: the validity of Lockheed's structural analysis and design of its interior bispherical pressure hull. In the tests this unique submarine hull survived simulated descents from ocean surface to 6,000 feet 10,800 times. It also withstood the design pressure of 5350 psi, the equivalent of a 12,000 foot depth. The hydrodynamic characteristics of Deep Quest have also been proven in an extensive series of tests at Sunnyvale, California, and Stevens Institute.

Scheduled for operations by the last quarter of 1966, Deep Quest will be able to carry a 700 cubic foot, 7,000 pound payload module to 6,000 foot depths. It will permit four men to conduct continuous submerged missions for 12 hours at four knots or 24 hours at two knots. Deep Quest's life support system capability extends to a total of 48 hours.

Lockheed brings an extensive backlog of experience gained in R & D and programs such as Polaris to the technology of deep submergence. For example, structures and materials, life support and sensor systems, materials, integrated controls, marine engineering, and advanced metals fabrication.

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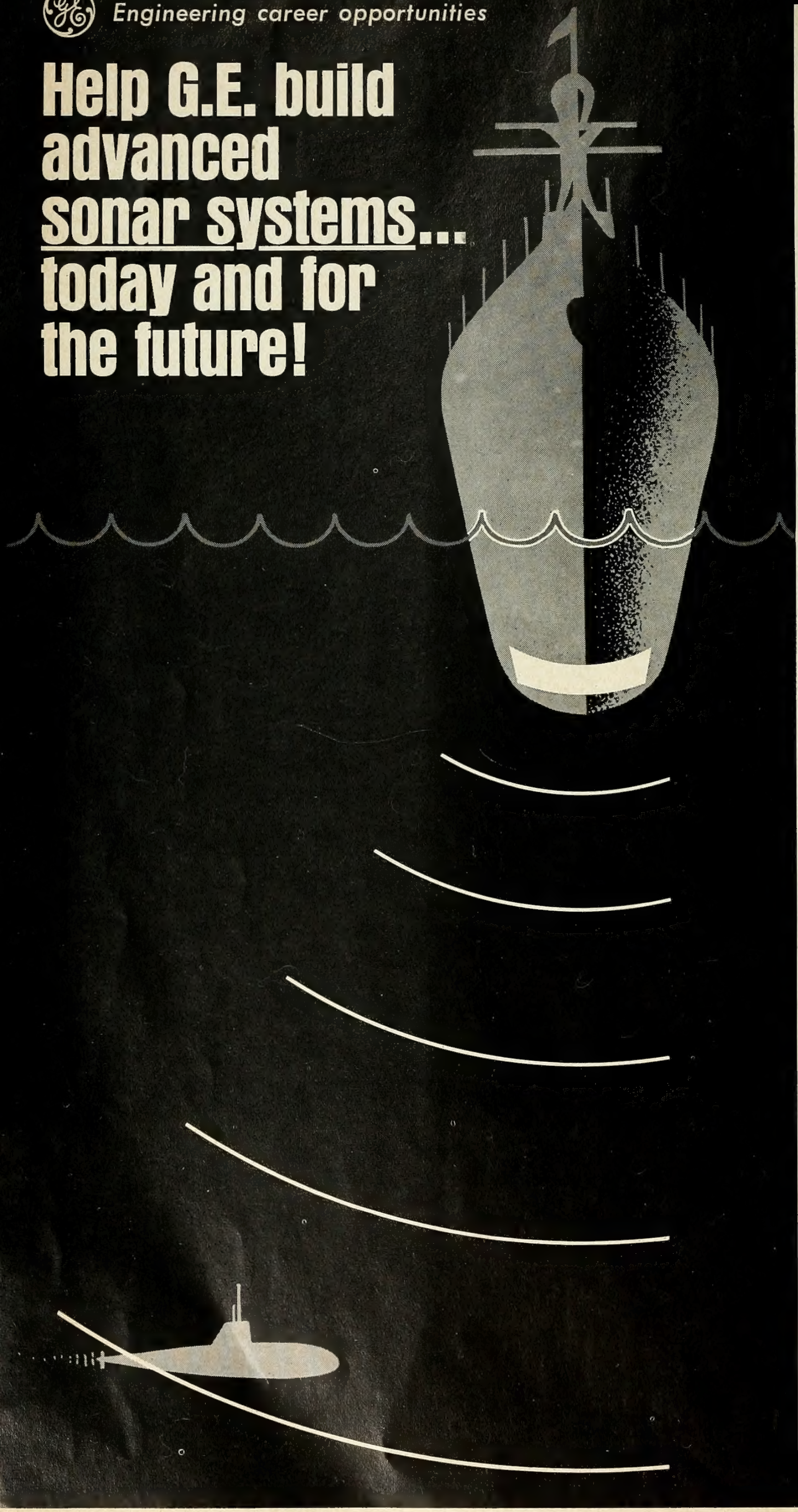

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OTHER IMPORTANT OPENINGS in: sonar solid-state circuit design; transducer development; solid-state transmitter development; pattern recognition analysis; others.

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missiles and rockets
THE WEEKLY OF ADVANCED TECHNOLOGY

Volume 17, Number 9 September 6, 1965

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THE COVER

SP-300 diving saucer owned by French oceanographer Jacques Cousteau and operated by the Westinghouse Underseas Div. off the California coast since early 1964 is highly maneuverable at 1,000-ft. depths. Submersibles are one of seven categories in M/R's special report on oceanology beginning on page 23.

WESTINGHOUSE PHOTO BY JOE THOMPSON

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SPECIAL REPORT: OCEANOLOGY

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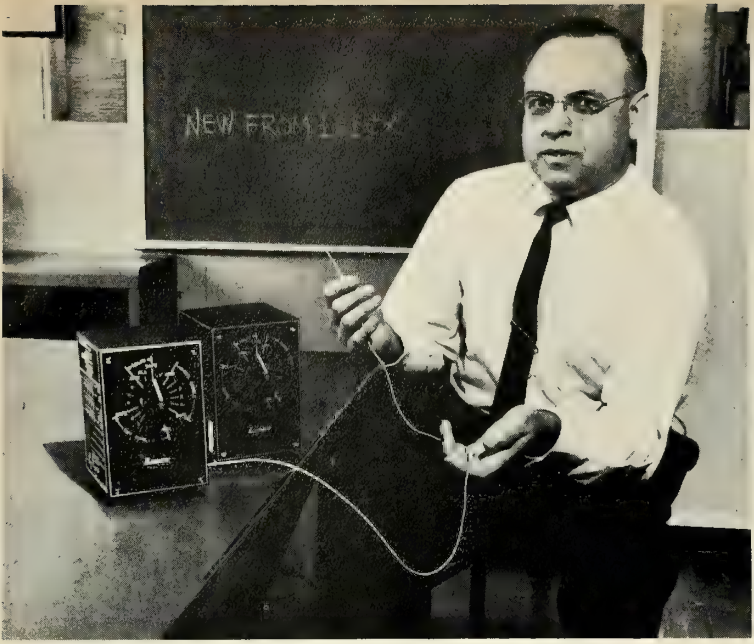
46,500 copies this issue



We had only one wire and 9 volts to operate these new control systems

These two boxes sit side-by-side in the belly of a non-expendable armament pod . . . which is attached to Northrop manufactured jet fighters used for combat training.

Inside each box is a 3-mode intervalometer which includes a selector switch and timing control circuitry. One box controls the release of 6 practice bombs. The other controls the firing of 4 rockets. In each case, control can be exercised in single, ripple or salvo patterns.

Now for the special requirements they gave us: "Design it to use existing wiring."

This put us out at the end of a single wire that had a 5-ohm resistor on it. As a result, what we had to work with was an input of less than 9 volts.

We took the nine volts on one wire and made accommodation to both boxes for: (1) timing pulses, (2) power to drive electromechanical switches, and (3) firing circuits, one of which involved the simultaneous ignition of 4 squibs. All circuits are grounded—except when being fired—to prevent firing by induced voltages from other electronic gear.

If you need a military or industrial packaged remote control solution, we're ready to help. Send for latest information on Intervalometers and Programmers. Our phone number is 513-224-9891.

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Earl Kerman
Section Leader,
Switch Systems Design

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letters

Multiplying Prefixes

To the Editor:

I was surprised at your footnote to the letter "One Man's Million" (M/R, June 21). I enclose a list of the accepted prefixes which have been adopted by the National Physical Laboratory in Great Britain and the National Bureau of Standards in U.S.A. The notes on the prefixes are my own, and I would particularly draw your attention to notes 1 and 2.

The misuse of m is particularly reprehensible when applied to power. Does mW mean milliwatts or megawatts? This is not a matter of individual choice; it is as important to follow standardization in this matter as in, for example, standard screw sizes.

I think it would be well worth while if you could make space available for the complete list, in your widely read magazine.

Dr. J. V. Hughes
Lytham, Lancashire
England

Dr. Hughes' list and notes follow:

The following multiplying prefixes were adopted in 1962 by the International Committee on Weights and Measures:

10^{12} = tera = T
10^{9} = giga = G
10^{6} = mega = M
10^{3} = kilo = k
10^{-3} = milli = m
10^{-6} = micro = μ
10^{-9} = nano = n
10^{-12} = pico = p
10^{-15} = femto = f
10^{-18} = atto = a

1. It is important to use a capital M for mega. A lower-case m stands for milli.
2. With one exception, all multipliers increasing the unit use capital letters. The exception is k for kilo, and present usage increasingly writes K for this symbol. It seems probable that K will be accepted for this within the next few years.
3. With one exception, all multipliers reducing the unit use small letters. The exception is the Greek letter μ for micro. This is very firmly established and will not be altered.
4. The microwave frequencies are usually expressed in kilomegacycles per second, abbreviated to kMc/s. The unit should be gigacycles per second, abbreviated Gc/s, and this is being increasingly used.
5. Very small capacitors, which in the past were expressed in micromicrofarads, abbreviated to μμf, should now be in picofarads, abbreviated to pf.
6. Infrared and visual wavelengths have in the past been expressed in microns (μ = 10^{-6} metre) and millimicrons (mμ). These are being replaced by micrometre (μm) and nanometre (nm) respectively.
7. The angstrom (10^{-8} cm = 10^{-10} metre) has now no reason for existence. It can be replaced by 0.1 nm or 100 pm.

INFRARED ENGINEERS AND SCIENTISTS:

Can you contribute to the development of products like these?

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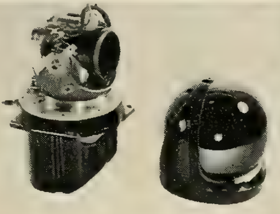
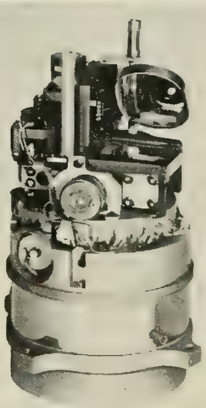
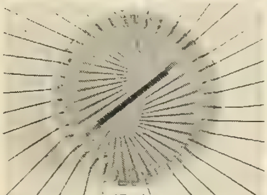
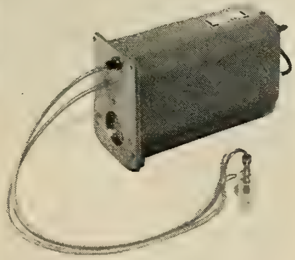
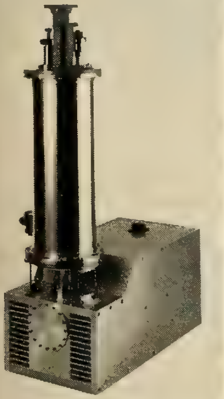

Interceptor IR search/track set.

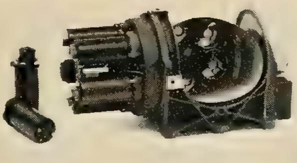
Anti-tank missile controller.


Star tracker for SURVEYOR spacecraft.


36-element IR detector array.


Miniature closed-cycle cryogenic refrigerator.


Cryogenically cooled parametric amplifier.


Radiometer for NIMBUS weather satellite.

Multi-element cooled IR detector.

Cast silicon IR optical components.

Rapid growth of Hughes infrared activities in the Aerospace Divisions and the Santa Barbara Research Center has created many responsible positions for qualified engineers and scientists in all phases of IR systems development from conception through production engineering.

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Current Hughes IR contracts include advanced systems for: space exploration, weather satellites, anti-ballistic missile defense, night reconnaissance, aircraft and space vehicle defense, and tactical weapon guidance and fire control.

Professional experience, an accredited degree and U.S. citizenship required.

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Hughes Aerospace Divisions
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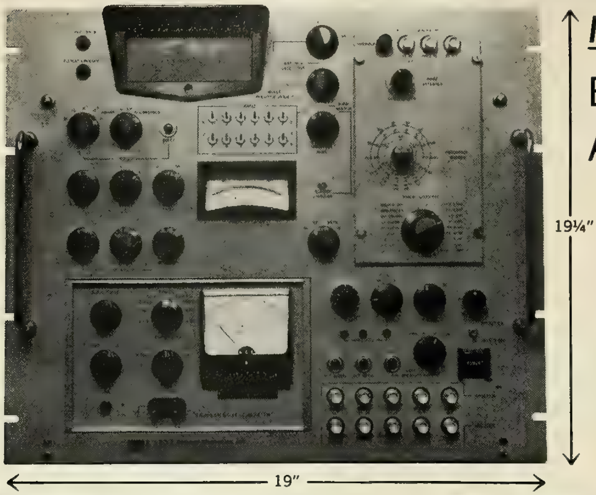

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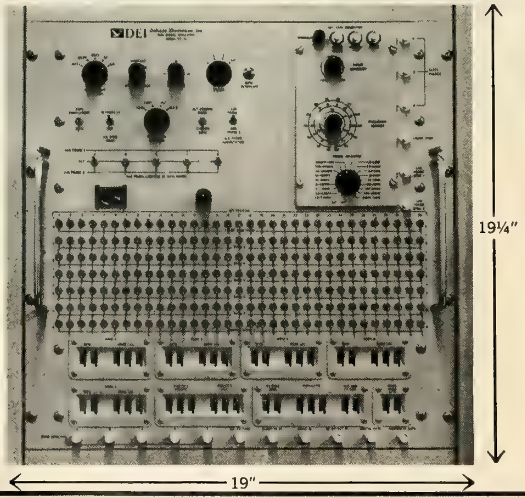

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The Countdown

WASHINGTON

Surveyor Test Foul-Up Delays AC-7

Problems encountered in testing the first engineering model of *Surveyor* have set back the launch date for *Atlas/Centaur 7* by at least two months. An error in a test procedure caused overvoltage to be applied. The extra surge affected the entire electrical system, damaging transistors, diodes and other components. Target date for delivery to the Cape of the engineering model fabricated at Hughes Aircraft Co., El Segundo, Calif., was Aug. 2; the mishap has caused this to slip to early October.

AES Study RFP Now Due Later This Month

Request for proposals on the program definition work for payload integration of the *Apollo Extension Systems* is expected to be issued this month by Manned Spacecraft Center. RFP has been delayed by NASA's inability to decide what responsibilities in the project will be given to which of its various field centers—and which resources at the centers can be used without injuring the *Apollo* program.

Congress Still to Be Sold on Big Mars Program

Senate Space Committee hearings on post-*Apollo* programs provided Chairman Clinton P. Anderson (D-N.M.) with an opportunity to make one thing clear to NASA: while approval of the initial few million dollars for the *Apollo* program in 1961 might have meant Congressional commitment to that undertaking, approval of *Voyager* funds in no sense means Congress is buying a long series of events leading to a manned Mars mission. Recent papers and statements on this subject by NASA officials from various centers appear to be causing some concern on the Hill.

Pan Am Patrick Cancellation Stirs Ruckus

The House Armed Services Committee's Special Investigations subcommittee will turn its attention to the cancellation of the Pan American services contract at Patrick AFB. Issue at stake has ramifications for similar contracts at other installations. Critics charged that DOD is trying to operate under an as-yet-unapproved directive which says that private business gets such contracts except for "military readiness considerations." An earlier directive, approved by Presidents Eisenhower and Kennedy and still in force, says "combat units in readiness"—a much more specific situation, it is charged.

Red-Cell Count Experiment on GT-5

An unpublicized first for *Gemini 5* was the use of radioisotopic techniques to trace the apparent loss of red blood cells noted in astronauts exposed to long periods of weightlessness. Extremely low doses of radiative iodinated (I-125) serum albumen and chromium were injected into the blood streams of the astronauts. Samples will be taken later and the red cells tagged by the chromium will be counted. While the loss of red cells in long-duration missions is not considered serious, NASA scientists want to be able to pinpoint how many will be lost and whether the degree of loss varies from individual to individual.

Apollo RCS Thrustors Intensively Tested

Four *Apollo* reaction control system (RCS) thrustors have undergone 15,000 test firings at Manned Spacecraft Center's thermochemical test facility. Another 10,000 firings are planned before tests end in about a week. The 100-lb. panel-mounted thrustors are fired in series of 300 pulses lasting 10-15 seconds each at a chamber-simulated altitude of 135,000 ft. MSC says engineers are evaluating their performance under "every possible combination of conditions."

Astronauts May Be Netted by 'Copters

Manned Spacecraft Center has developed a scoop attachment to use in helicopter recovery of astronauts. Employing a retractable rigid boom and a net attached to the helicopter's forward section, it permits the pilot to keep the astronaut in view at all times. The space agency hasn't said when the boom may be used in an actual recovery.

INDUSTRY

Comsat Global System Gets Quick Reaction. . .

Initial response to Comsat Corp.'s recent RFP for an advanced global communications system indicates strong interest within the industry both in the U.S. and abroad. At least five U.S. firms—TRW, Hughes, Philco, RCA and General Electric—have indicated they'll submit proposals for the system, which will be placed in either a synchronous or phased medium-altitude orbit. Fifteen foreign companies were notified when the proposal was issued Aug. 17, but it has been learned that at least 40 or 50 such firms now have copies of the RFP.

. . . And RCA Is Very Much in the Contest

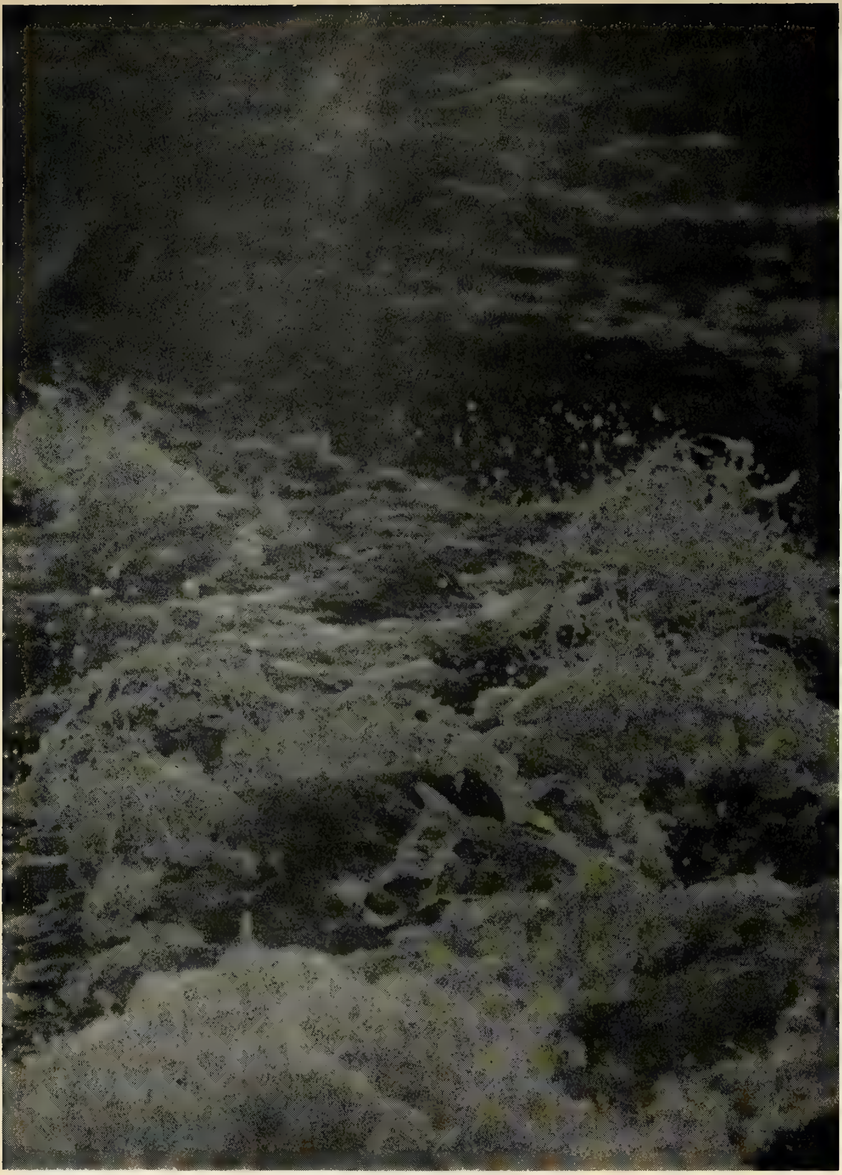
Denying a report that appeared last week in some daily newspapers, RCA officials assert that the firm will put in a strong proposal for the global system. The erroneous report apparently stemmed from RCA's decision not to bid on Comsat's *Apollo* system RFP. (Hughes was the only company to tender a proposal.) Actually, 47 persons from seven RCA divisions attended a recent company meeting on the global-system request.

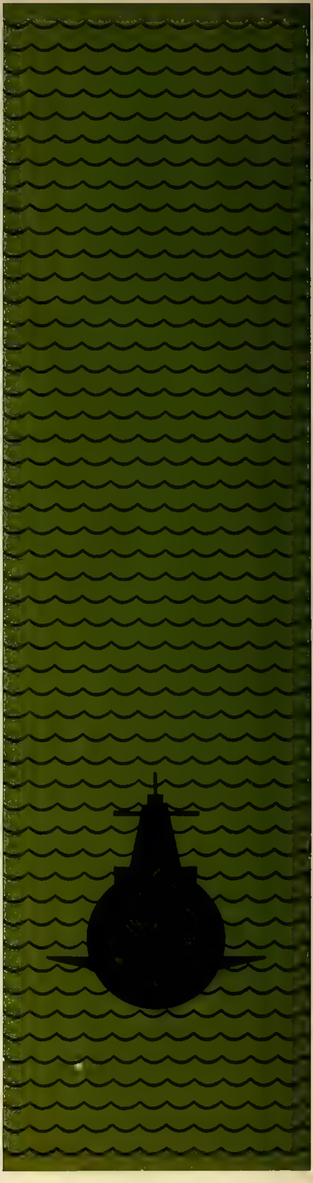
GD/C Picked to Study Centaur for Saturn Use

General Dynamics/Convair has been selected to determine the vehicle design changes and ground support equipment required for use of the *Centaur* high-energy vehicle as the third stage of the *Saturn IB* booster. All major *Centaur* systems will be examined during the six-month, $100,000 study. The *Saturn IB/Centaur* vehicle will stand approximately 198 ft. high, weigh about 1.3 million lbs., and be capable of boosting a 9,500-lb. *Voyager* toward Mars.

New UTC Rocket Aimed at Long-Life Missions

United Technology Center says it has developed a liquid-fuel rocket that has demonstrated higher efficiency than any other known liquid motor of comparable size. Designed for advanced missions such as satellite rendezvous and inspection requiring long space life and precise control, the rocket reportedly can be throttled from 9,000 to as low as 170 lbs. of thrust. Specific impulse is classified. Static-tested nearly 100 times so far, the engine has a lightweight, ablative thrust chamber 12 in. in diameter and 30 in. long. Storable propellant of nitrogen tetroxide and a 50-50 blend of hydrazine and UDMH, together with new design features, will provide in-space start-stop capability for two years, UTC says, and a total burn time of more than 150 secs.





"He maketh the deep to boil like a pot…"

This was Anti-Submarine Warfare (ASW), Old Testament version (*Job* 41:31).

ASW, 20th-century Navy style, is something else.

It is thousands of men, planes, ships and subs — tied together by a staggering array of electronics. It is long patrol flights, long months on station, lonely watches. It is everything — fused into a potent, single-purpose defense system. From the Arctic to the Antarctic — in, on and over the seven seas.

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Brown Lauds Crime Study

California Gov. Edmund G. Brown intends to request assistance from Federal officials to implement recommendations contained in a comprehensive report on crime recently completed at his request by Space-General Corp.

The report is the result of a six-month, $100,000 study of crime in the state, and was described by Gov. Brown as an "unqualified success" when he indicated his intention to seek help from Washington.

Conclusions contained in the study, one of four requested of aerospace firms in the state (M/R, Feb. 15, p. 24), show that crime will increase in California almost twice as fast as the population increases in the next 10 years, that California criminal justice costs $600 million a year now and that this figure will jump to $900 million a year by 1975.

Space General said the study, which used computers and simulation techniques as well as thorough field investigations, shows that while modern techniques make it possible to send photographs of Mars from 325 million miles in space, police have no similar methods of sending fingerprints from one end of the state to the other.

The study showed that bad check writers are the costliest problem in California, averaging a cost of $16,900 to the state through their lifetimes. It also said the reason for the fast crime rate increase is the continuing "tremendous" increase in the number of persons in the 14-29 year age group, where most of the crime occurs.

AF Studies Non-Profit Firms

The Air Force will complete by the end of the year a study on the use of non-profit organizations for the management of Air Force programs, apparently spurred by Congressional interest in the subject.

An eight-member board, which held its first meeting recently, consists of members of the Air Force's board of visitors, including Howard Johnson, dean of the Alfred P. Sloan School of Management at the Massachusetts Institute of Technology as civilian chairman, and Maj. Gen. John W. O'Neill, commander of the Electronic Systems Division as military chairman. Other members are Charles Anderson, president of Walker Mfg. Co.; Dr. William Baker, Bell Telephone Laboratories vice president; Malcolm MacIntyre, Martin Marietta vice president; James Kerr, president of Avco Corp.; Lyle Garlock, Eastern Airlines vice president; and Gen. Nathan F. Twining (Ret.), former chairman of the Joint Chiefs of Staff.

Experiment Proposals Sought

The space agency has asked scientists to submit proposals for experiments to go on the *Apollo* and *Voyager* spacecraft and at least 10 other major satellite projects.

The request is contained in the publication of NASA's semi-annual "Opportunities for Participation in Space Flight Investigations." The largest part of the booklet is devoted to the *Apollo* program, with 44 of its 107 pages detailing opportunities provided by the Earth-orbital and lunar landing missions in the three-man space program.

The opportunities include placing scientific instruments in available space on unmanned satellites and orbiting observatories, sounding rockets, balloons, the NASA Convair 990 and *X-15-A2* research planes, plus lunar and Martian exploratory missions.

Proposals are also sought for experiments on spacecraft in such major NASA projects as *Lunar Orbiter, Surveyor, Voyager, Orbiting Solar Observatory, Advanced Orbiting Solar Observatory, Tiros, Nimbus, Explorers* and a joint U.S.-Canadian satellite, *ISIS*.

Flight dates generally cover the period from 1966 to 1972. Deadlines for proposals vary according to each project.

The scientific community is also being asked to propose experiments which would require missions not presently planned and to submit design studies for future scientific investigations.

GE Develops New Fuel Cells

New fuel cells, offering up to four times the operating life of the type used in the recent *Gemini 5* flight, are under development by General Electric's Fuel Cell Laboratory in Lynn, Mass., and its R&D Center in Schenectady, N.Y.

Employing a new solid-polymer electrolyte similar to Teflon, the new cells have shown extreme resistance to chemical wear, according to Roy S. Mushrush, manager of the GE development effort.

Also under way, he said at a press conference in New York last week, revealing current state of art of the firm's advanced fuel cells, are similar units that operate on hydrogen and air (instead of H_2 and O_2) and on hydrocarbon fuels and air.

Cells using the new solid-polymer electrolyte are now in pilot production at the Lynn facility, he disclosed. Although they will not be available for operational use in the current *Gemini* program, GE officials stated the cells could be employed in future longer space and lunar missions as well as in ground or underwater applications.

Single test cells reportedly have been operated at temperatures from 100° to 140°F continuously for more than seven months without signs of wearout. Water, a by-product of the operation, has been free of impurities, Mushrush claimed.

New Computer Series Bows

First in a new series of microminiature computers that range in complexity from small airborne units to complex multi-processor systems, simply by adding modules, has been announced by the Data Systems Div. of Litton Industries, Inc., Van Nuys, Calif.

A proposal team briefed the *Manned Orbiting Laboratory (MOL)* staff at Douglas Aircraft Co. on the series last week.

Other applications envisaged are airborne electronic surveillance analysis, fire control, early warning or command and control. On the ground, the equipment is "extremely applicable to the CCIS 70 Army program," said Leon Bloom, technical manager of Litton's advanced computer systems department, adding, "we will probably be proposing it in every area. The compatibility between the very small system and the very complex is important here."

First member of the series of stored-program general-purpose machines is the L-304, which is offered with 4,096- or 8,192-word memory modules that have 1.6- and 1.8-microsecond memory cycle times, respectively. With four 8,192-word memory modules, the L-304 costs about $150,000.

Memory storage can be increased by adding memory modules. The basic machine can directly address up to 32,000 words. Modifications enable

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Aero/Thermo
Heat transfer and fluid mechanics for thermal analysis of booster and space vehicle systems.
Life Support and Environmental Control
Design analysis integration development and or Fortran experience.
Electrical Engineers
Automatic Test Systems. Requires experience analyzing design requirements to control product quality.
Structures
Structural elements, thermal protection systems, pressure vessels. Conceive, design components/systems.
Propulsion Design
Set design criteria and evaluate solid and liquid systems.
Advanced Propulsion Systems
Set preliminary design criteria for solid and liquid systems.
Control Systems Engineers
Design, analysis: Thor.
Ground Support Equipment
Design & test ground support equipment. Design electrical systems.
Chemist/Chemical Engineer
Design, develop: Electrochemical, life support devices and pre-treatment techniques for waste fluids.
Chemist—Fuel Cells
Applied electrode technology catalysis, or electrochemical technology.
Mathematician
PhD. Help make new, special purpose computers/programs.
Battery Technologists
Design, fabricate, test: High energy density batteries, electrodes, separators, cases, seals, components.

it to address 131,000 words.

Monolithic integrated circuits are used extensively, chiefly in the form of the TFX gate. Hybrid circuits are used to drive the core storage unit, which is produced by Ampex.

A number of programs can be called on independently, by external interrupts or internal program priorities. The machine has eight program registers per program level and a possible 64 program levels. All registers are stored in core memory. The L-304 can handle 64 input-output devices operating on-line, with a maximum data-transfer rate of 312,000 words per second.

An important feature of this machine is that when its power supply is cut off, no data are lost. When power is restored, it picks up its computation where it left off.

Hughes Gets Apollo Optics

Hughes Aircraft Co. has been selected to develop an optical tracking system for the *Apollo* spacecraft, which will be developed in parallel with a rendezvous radar system already being developed by Radio Corp. of America.

NASA's Manned Spacecraft Center said the choice between the two developments, tagged at less than $50 million each, will be made "some time next year." AC Electronics Div., General Motors Corp., prime contractor for *Apollo*'s guidance and navigation system, had solicited Hughes' approach from three contracted studies looking into optical tracking methods (Itek Corp., Perkin-Elmer Corp. and Hughes).

The Lunar Excursion Module optical rendezvous system (LORS), as proposed by Hughes, consists of a star-tracking device on the LEM that searches, finds and locks onto a high-intensity beacon of the *Apollo* Service Module to obtain angle and azimuth information as a function of time. This data is fed into the LEM on-board computer, compared to a stored program within it, recalculated and displayed as direction and amount of thrust to be accomplished by the LEM to effect a rendezvous with the other vehicle.

Proponents of the LORS say the optical technique is less complicated than a rendezvous radar system and therefore "more reliable" with one-fourth the electronic parts. According to their calculations, it contributes to a weight saving of 80 lbs. in the LEM ascent stage, which can be further translated to 340 lbs. gross weight of the LEM, 500 lbs. gross weight of the Service Module, and 33,000 lbs. gross weight at mission lift-off.

In the meantime, RCA is developing an X-band rendezvous radar system for the LEM to provide range, range-rate, azimuth and elevation information from response to signals sent to an X-band transponder aboard the *Apollo* Command Module. The RCA radar is capable of operation up to 400 n. mi., MSD said.

Shots of the Week

The launch schedule was light at U.S. and foreign missile ranges in the week ending Sept. 1.

- A B-52 bomber of the Strategic Air Command successfully launched a *Hound Dog* missile Aug. 30 while on a training flight down the Eastern Test Range.
- Air Force Maj. Robert Rushworth took the *X-15* rocket plane to 240,000 ft. and a speed of 3,409 mph in an Aug. 26 flight over Southern California and Nevada to obtain boundary layer noise measurements and scan the Earth's horizon.

Sealab Experiment Begins

Astronaut M. Scott Carpenter and three other divers began a 45-day experiment in Sealab II Aug. 28 near La Jolla, Calif. (See p. 47).

Carpenter was scheduled to spend 30 days in the vessel, which is submerged at 205 ft. some 1,000 yards off shore. The Navy test is intended to determine how long men can function at extreme depths. A Navy spokesman said 30 days would be a record at such a depth. Four men spent 11 days at 192 ft. last year in the Sealab I vessel off Bermuda.

The divers accompanying Carpenter will be relieved after 15 days. In all, three teams will man the underwater base during its sojourn.

BUIC System Goes to Work

The first station in the $100-million Backup Interceptor Control (BUIC) system became operational Sept. 1 at North Truro, Mass., near the tip of Cape Cod.

The system will ultimately have 13 computer-controlled sites for detecting enemy aircraft. It was designed at Hanscom Field, Mass., by the Air Force System Command's Control Electronics Systems Div.

BUIC is designed to take over air defense functions in the event the Semi-Automatic Ground Environment (SAGE) system fails or is destroyed in any enemy attack.

NASA Cranking Up for Gemini 6 & 7

GT-6 to be mated at Cape this month; Gemini 7 getting last tests; officials enthuse over systems performance

by Jinx Mercer

GEMINI PROGRAM PLANNERS are gearing operations for two more manned shots this year—a two-day rendezvous and docking mission by late October, followed by a rapid recycling for a 14-day flight in mid-December.

NASA's Manned Spacecraft Center said the *Gemini 6* spacecraft and the *Titan II* booster will be mated at Cape Kennedy later this month. The *Gemini 7* spacecraft is in final test at McDonnell Aircraft Co. and the *Gemini/Titan II* launch vehicle is reported nearing delivery at the Martin Co.

The *Gemini/Titan/Agena 6* mission will be the first attempt to countdown and launch two vehicles from Cape Kennedy within 90 min. of each other. The *Agena* will be lofted by an *Atlas* launch vehicle into a circular, 161-n.-mi. orbit. The two-man *Gemini* spacecraft will follow 90 min. later, establishing itself in an 87/147-n.-mi. elliptical orbit. The rendezvous maneuvers will begin one orbit later, and both vehicles will be within docking distance over Hawaii by the fourth orbit.

Current plans call for several docking attempts with the *Agena* stage. Astronauts Walter M. Schirra and Thomas P. Stafford will perform experiments in proximity to the *Agena* and in the docked position with the stage, but are not expected to emerge from the spacecraft in extravehicular (EVA) activity.

Post-flight analysis of *Gemini 5* computer data has revealed that an error in computations existed in the real-time computer complex (RTCC) program that was used to instruct the spacecraft in specific bank angles for the controlled glide to splashdown.

A spokesman for the Manned Spacecraft Center said the error became compounded over the eight days of flight, causing the onboard computer to bring the spacecraft down 89 n. mi. uprange from the prime recovery ship, the carrier Lake Champlain.

- **Fuel cells "exonerated"**—At the post-recovery press conference in Houston, Charles W. Mathews emphasized the flexibility displayed by the spacecraft equipment. The *Gemini* program manager said that the General Electric fuel cells could have continued "another 30 days" judging from their performance up until retro-fire. He called the *Gemini 5* flight "the most interesting to date."

Mathews said that in tests run simultaneously with the mission, McDonnell engineers continued operating the fuel cell beyond water production storage limits, allowing the water to back up and begin flooding the fuel cell.

It ran for 38 hrs., operating properly up to that time, and then indicating a drop in voltage. He said the section "gurgled" when it was being purged, venting several thousand cubic centimeters of water on both the hydrogen and oxygen sides, but returned to "spec" operation.

"This seems to be a device that can

LEFT: In Gemini 5 recovery area, Cooper (in life raft) and Conrad prepare to go to prime recovery ship, USS Champlain. Launched at 10:00 a.m. EDT Aug. 21, spacecraft splashed down at 8:56 a.m. EDT Aug. 29. RIGHT: Recovery of 17 ft. of first stage of Gemini 5's Titan II booster aboard destroyer USS Dupont. Stage section, which re-entered 450 mi. northeast of Cape Kennedy, was first ever to be retrieved from space. Martin Co. engineers in Baltimore asked that it be returned for study.

take quite a beating," Mathews said.

"The fuel cells weren't the things that exhibited any abnormal behavior. It is the cryo storage system that feeds the fuel cell system that had problems," he said. "We have a scheme in process now that will allow us to pressurize the O_2 tank from the breathing environmental control system bottle." He explained that this would give them a backup in the event the O_2 heater failed.

They are also looking into achieving "less transfer of heat into the storage bottles—these bottles are very highly insulated, but we want them even better," he said. They were looking into some "fairly simple schemes" at reducing the transfer.

- **Gas storage closely watched**—Gases in a supercritical state were flown in space longer during *Gemini 5* than ever before, he remarked. "One of the big problems is storing these fluids over extended periods. This is important for the lunar mission." He emphasized that the experience gained in this flight was contributing to the technology for advanced missions.

Plans to recover the Westinghouse rendezvous radar dimmed when the spacecraft landed short of its mark. Helicopters arrived too late to pick up the rendezvous and recovery canister containing the radar, which was jettisoned shortly before splashdown. The R&R canister remained afloat for a short time, then sank.

Mathews said the radar performed satisfactorily initially and the crew was able to track the radar evaluation pod (REP) before it was instructed to scrub the exercise.

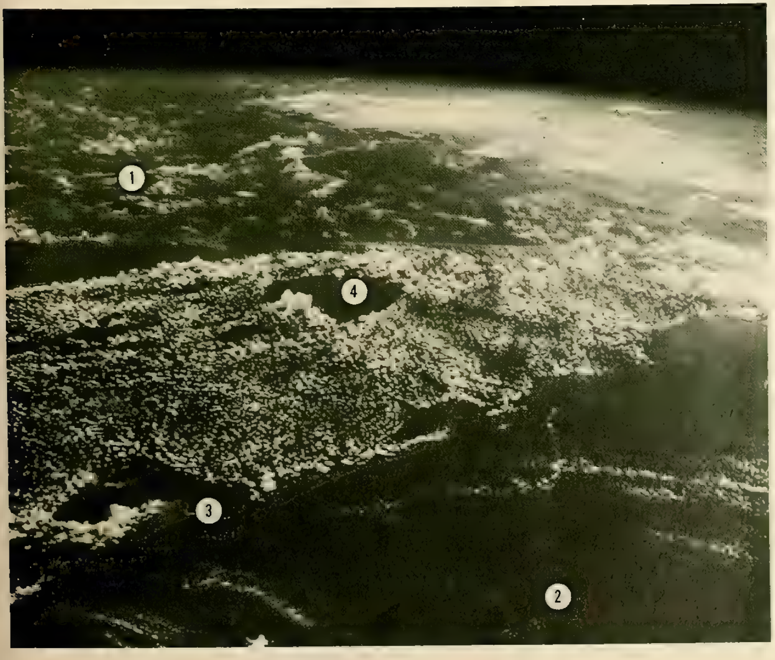
"We still have some problems with the radar," he said, explaining that in subsequent tracking of an L-band transponder set up at Cape Kennedy, the crew was able to track in angle, but not in range. He added that this would not affect plans to rendezvous and dock with an *Agena* vehicle during the next mission.

"Just having the equipment operate over eight days is a fairly reasonable exercise," he said. "It was very encouraging that the new equipment worked so well."

In describing the physical condition of the astronauts, Dr. Charles A. Berry said Command Pilot Gordon Cooper and Pilot Charles Conrad, Jr., showed no adverse effects either from weightlessness or from their long confinement. Early reports indicated that the crew was "healthy, happy and aware." They were instructed to do deep-knee bends and were able to stand and walk with no apparent difficulty, the physician reported.

Heart rates during the mission "showed an adaptation to the weightless condition," he said. During the latter part of the mission, both men had heart rates that were lower than they were before the flight—"in the 50's and 60's."

PHOTO TAKEN by astronauts using Hasselblad camera quite clearly shows southern Florida despite partial cloud cover. North is at left. Numbered areas indicate 1) Atlantic Ocean; 2) Gulf of Mexico; 3) City of St. Petersburg; and 4) Lake Okeechobee. Picture was one of a series released by MSC.



The heart rates reached the 150's at launch, he said. During the first day of flight, the rates remained in the hundreds and about the third or fourth day leveled out in the 50's and 60's. During sleep period, their heart rates dropped to the high 30's and low 40's, he continued. "The rates at retro-fire peaked out at 180."

- **Returning to normal**—In a medical briefing at Cape Kennedy Aug. 31, Dr. Berry reported that the crew blood-pressure readings were nearly back to pre-flight normal. The heart rates were still below normal, but this was a "typical response." The same pattern was observed in the *Gemini 4* crew, he said. "It takes longer for heart rates to reach baseline normals than it does for blood pressure."

From outward appearances, the crew looked "less tired" than the *Gemini 4* crew did after their flight last June. He said the crew recommended that future flights have single sleep periods for both men, rather than sleep periods in shifts. Their complaint was that the slightest activity by the other crew member disturbed sleep.

Dr. Berry said that both men lost weight—about 10 lbs. each—despite eating and drinking regularly. There will be changes in food carried on the 14-day mission, but mostly for storage reasons, he said.

Regarding calcium loss in the bones, detected in post-flight measurements of the *Gemini 4* crew, he said: "I don't think it will ever become an operational problem of any magnitude at all." As far as orthostatic hypotension tension was concerned, he said he didn't think they were going to see "anything too different on the 14-day flight."

Nasal congestion reported by the crew in flight was unexplained. Berry said that Cooper felt congested on the second day, while Conrad experienced swelling of mucous membranes in the 48-hr. period. Berry's first guess was that the congestion was due to dehydration, but added that he could not explain why the congestion occurred in space and not in ground chamber tests of longer periods. There were no post-flight findings in either of the two men to give any reason for the congestion.

The question was asked how he could explain the difference in Cooper on this flight as opposed to his previous flight. Berry said, "I think for one thing, McDonnell gave him a much better spacecraft to fly in; and I think the systems were excellent this time, and he was much more comfortable for the entire mission. Secondly, he had water to drink this time and maintained his hydration, which he did not do during the previous mission; and I think's that's enough to explain the difference." ■

Schriever Given Direction of MOL

Evans named vice director, Berg to head office at SSD; Sperry Rand to get subcontract; others on Douglas team wait for word

THE AIR FORCE MOVED with infinite care last week to spell out management responsibility for the *Manned Orbiting Laboratory (MOL)* program.

Its intention to keep top-level control over the effort was emphasized with the announcement that Gen. Bernard A. Schriever, commander of Air Force Systems Command, would be manager of the *MOL* program office at the Pentagon, reporting directly to Secretary of the Air Force Dr. Harold Brown. However, little information emerged regarding contract details or relationships.

Vice director of the program is Brig. Gen. Harry L. Evans, who has been serving as special assistant to the Secretary of the Air Force for *MOL* at the Pentagon. Brig. Gen. Russell A. Berg moves into the *MOL* office at the Space Systems Division headquarters, as deputy director of the *MOL* program and deputy commander-SSD for *MOL*.

Brig. Gen. Joseph Bleymaier, closely identified with the *MOL* program and the force behind the *Titan III* standard space launch system, was moved to command of the Air Force Western Test Range, with headquarters at Vandenberg AFB, Calif.

There was some speculation following the announcement of Bleymaier's transferral that the Air Force would move the Satellite Control Facility under the National Range Division to gear up for *MOL*. However, there was no confirmation of this from AFSC.

- **Explanation sought**—Little more was disclosed on the nature of contracts and subcontractors, except for the announcement by Sen. Robert F. Kennedy (D-Mass.) that Sperry Rand would receive a subcontract for the stabilization and control system. Other subcontractors who were on the bidding team with Douglas Aircraft Co., prime contractor, had received no word as to whether they would be included.

Part of the delay in working out the management details was attributed to the care with which the Air Force is delineating the responsibilities of Aerospace Corp., which will provide systems management services. After considerable criticism from a Congressional committee (M/R, Aug. 23, p. 14), the Air Force has under way a study on the use of non-profit institutions in the management of its programs (see p. 11).

Other team bidders awaiting news were International Business Machines, data management, guidance and navigation; and Collins Radio, communications. Both Hamilton Standard and Garrett's AiResearch Mfg. Co. worked with Douglas on the environmental control system part of the contract, and the remark by a high Defense official that life-support technology for *Apollo* will be adapted for *MOL* could apply to either company. Garrett is contractor on the *Apollo* Command Module life-support system, while Hamilton-Standard has the counterpart for the Lunar Excursion Module (LEM).

- **Gemini under way**—Contracting for the *Gemini* portion of the laboratory was translated into the dollars-and-cents level as McDonnell Aircraft Corp. received a $4-million initial increment of a $6,784,061 fixed-price Air Force contract for an engineering study of the *Gemini* portion of *MOL*. The contract was awarded from the Space Systems Division of AFSC.

McDonnell earlier disclosed that it has been working for a year on the *Gemini-B* on Air Force money, under a $1-million contract from SSD. The company said that it has been using company funds for more than three years on a *Gemini-B* design "in the firm belief in the *Gemini's* potential as a real work-horse of space."

The spacecraft differs from the NASA *Gemini* in that a hatch will be cut in the heat shield through which the astronauts will enter the *MOL*, and that it will weigh about 6,000 lbs. compared with the normal 7,000, as some equipment is common with that in the laboratory.

McDonnell is working now on a $3-million contract issued by NASA for the Air Force to rebuild the *GT-2* spacecraft to study the new heat shield configuration in an unmanned test in 1966, pre-*MOL*.

Sen. Kennedy also disclosed that Sperry Rand will employ 300 to 400 engineers on early engineering development in the near future, a number which will increase with production.

- **Previous statements**—DOD officials estimated a cost of $23 million incrementally over the duration of the program to make up a ground support facility to meet *MOL* requirements out of elements of the National Range Division, the Satellite Control Facility, and occasional use of one or two NASA stations. They said the low cost would be possible because the stations are already operating on a 24-hour day manned basis.

DOD told Congress earlier this year that it would take full advantage of the Satellite Control Facility, which has headquarters in California and six associated stations.

In 1964, the SCF network achieved over 10,000 station contacts with active satellites. In 1963, it supported over 50% of all active satellites in Earth orbit. The Control Center is capable of supporting as many as 10 satellite missions simultaneously.

Use of NASA's Mission Control Center at Houston has been ruled out, although the possibility has been discussed that the Air Force will take over the *Gemini* Mission Control Center at Cape Kennedy. ■

Success Ends McDonnell MAW Testing Early

ARMY MISSILE COMMAND has discontinued guided flight testing of the McDonnell Aircraft entry in the *MAW* (*Medium Antitank Weapon*) competition because "there are no remaining areas of technical uncertainty."

The Army said the decision was based on the high level of demonstrated success achieved during the exploratory development program.

The other remaining entry in the competition for full-scale development is the Army Missile Command's own free-rotor gyro version. The McDonnell *MAW* is wire-guided.

"It is doubtful that additional testing would make a significant contribution to the benefit of the Government," AMC advised McDonnell. ". . . it is the opinion of the technical director that you have satisfied the objectives and scope of the contract."

Thirteen of the scheduled 15 firings were completed before termination of the one-year contract.

Aerospace Employment Leveling Off

Gain foreseen between March and December set at only 0.8%; demand for aircraft to trigger dip in missile/space personnel

by Suzanne Montgomery

A SLIGHT RISE in total aerospace employment and a greater increase in the number of scientists and engineers in the field is predicted for the period from March to December, 1965.

A significant shift of aerospace employees from missile/space work to aircraft-related activities is also indicated by the latest employment survey by the Aerospace Industries Assn.

Released this week, the survey of 53 member companies of the AIA estimates a 0.8% gain in aerospace employment between March and December—from 1,123,000 to 1,132,000—and a 7.3% rise in the number of scientists and engineers—from 177,000 to 190,000.

For the first time, however, there will be a substantial move of aerospace employees away from missile/space projects and toward aircraft work, the study predicts. Aircraft workers are expected to account for 56.7% of the total aerospace employment by December, an increase of 3.2% from the March figure. Employment in the missile/space portion of the industry is anticipated to drop by 7.3%, from 481,000 to 446,000. This will account for 39.4% of the total employment picture in aerospace activities, compared to 42.8% in March.

The survey also predicted a trend toward stability of aerospace employment throughout the country. Total share of activity in the West Coast area is expected to drop from 42.7% to 41.2% during the nine-month period covered.

- **R&D personnel up**—Despite the overall drop in employment in missile/space activities, the number of scientists and engineers in the area is expected to rise by 4.2%—from 96,000 to 100,000. The increase contained in the total decline probably represents the increased emphasis on research and development work, as opposed to production work in the area, the report suggested. However, as a proportion of the industry's scientists and engineers, the missile/space group will drop from 54.8% to 52.7%, the survey indicated.

Participation of employees in nonaerospace activities will continue to show a slow and gradual rise, climbing from 42,000 in March to 44,000 in December, an increase of 4.7%. Application of aerospace technology to other industries should account for about 3.9% of the total employment by December, the survey predicted. Employment of scientists and engineers in the area is expected to remain about constant.

After several years of a relatively steady increase in missile/space employment over aircraft employment, this is the first time the AIA survey has indicated the opposite trend.

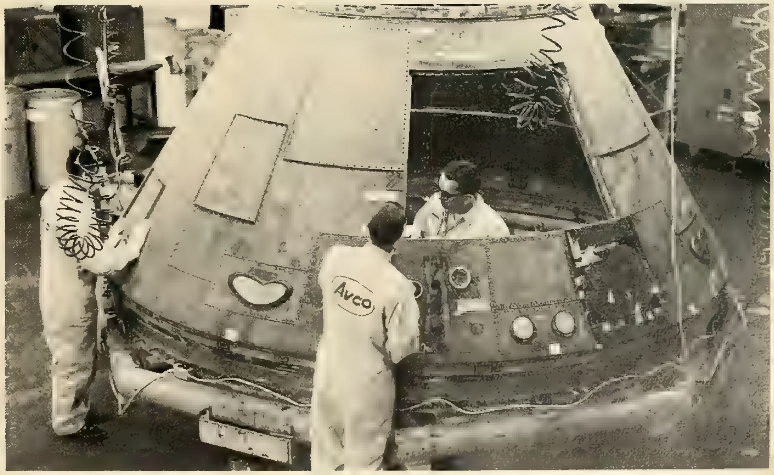
Within the industry total, aircraft employment is expected to increase by 7%, from 600,00 to 642,000. Aircraft's percentage gain will result from increased airline commitments for transport aircraft and rising aircraft demands for support in Viet Nam, the survey report said.

- **Geographic breakdown**—The overall decline in aerospace employment in the Pacific area—California, Oregon, Washington, Hawaii and Alaska—is followed by slight increases in the west north central, south central, New England and Middle Atlantic areas. At the same time, the drop is contradicted by a rise in the percentage of scientists and engineers working in the Pacific area. The number is expected to reach 43.7% of the total in December, compared to 42.8% in March.

The Pacific area also shows the greatest shift from missile/space to aircraft activities. Missile/space employment is expected to drop from 68.3% to 64.8% in those states in relation to total missile/space employment. Aircraft employment within the area will rise from 25.1% to 27.6% of the nation's total by December, the survey indicated. All other areas are expected to show stability or a slight decline in missile/space employment.

AIA pointed out that in the product group breakdown, the missile/space category is somewhat misleading. The association noted that the industry's workload for space is increasing. However, in this type of quantitative survey, it is virtually impossible to differentiate many of the elements as being either missile-oriented or space-oriented.

All predictions for December employment figures should be considered conservative ones, the association said. Employment forecasts for June made last January were only about 91% of the employment realized when the forecast period became history, the association pointed out. ■



Plugging 'Holes' in Apollo Heat Shield

FINISHING TOUCHES to the ablative heat shield for the main crew compartment of NASA's Apollo Command Module are performed at Avco/RAD, Lowell, Mass. Special guns are used to inject ablative material—a phenolic epoxy resin—into each of more than 350,000 honeycomb cells. Some 1,000 bolt holes will also be plugged.

'Adaptive Telemetry' Gains Reported

Lockheed presentation is a highlight of WESCON; Stanford expert discusses merits of heterodyne detection of pulsed optical radar returns

San Francisco—Programmable PCM systems and new data-compression techniques for adaptive telemetering were among the many advanced concepts presented by Lockheed Missile and Space Co. at the recent Western Electronic Show and Convention (WESCON), held here Aug. 24-27. (See also M/R, Aug. 30, p. 10.)

Focusing upon its rapidly expanding interest in telemetry for aerospace vehicles, the firm detailed some prototype hardware and potential applications for new systems.

Solid-state, multiplexed PCM telemetry systems will be used with increasing frequency for the more complex aerospace missions, Lockheed engineers asserted. There is also no doubt, they said, that the pace has been stepped up in the effort to build into PCM technology the ability to provide more flexible control of both the type of data that can be accumulated by a single system and the amount of that data that is actually transmitted.

Study contracts for some of these "adaptive-telemetry" systems were awarded earlier this year by NASA's Manned Spacecraft Center in Houston, which has been responsible for much of the new impetus in this field. However, many U.S. firms, including Lockheed, have been advocates of this technique for several years, proceeding largely on their own funds.

Lockheed's programmable PCM effort was begun in June, 1964, and an engineering prototype has been built and demonstrated. Programmable PCM telemetry differs from fixed-sequence telemetry basically in that sample rates, channel selection, and data format can be varied primarily by software changes rather than by altering the hardware. This can be done either on the ground or through an RF command link.

• **System described**—The Lockheed approach makes use of random-access multiplexing and stored-program control. Described by N. N. Berger and R. W. Ulrickson, the system uses 256 rows of memory as an "instrumentation list" for the randomly addressable 96-channel multiplexer. The multiplexer, they reported, is commanded to each data channel by a seven-bit binary word from the memory. Address words may be stored in memory in any order and may be repeated as often as needed.

The frequency of occurrence of a given channel address as the memory is accessed sequentially determines the sampling rate of that channel. By interspersing high- and low-rate data addresses in the memory, efficient use of bandwidth can be achieved. Although the memory is read sequentially, they reported that it can be loaded with random access while cycling.

The four main components of the prototype system include two multiplexers, the memory, and the encoder with power supplies. The system is reportedly capable of handling data rates in the range of six samples per second to 6,000 spc, with 96 channels of 0-15v data and 32 channels of 20-mv data. Quantizing resolution is 8 bits, and maximum output bit rate is 1 megabit. The system weighs 15 lbs., occupies 526 cu. in., and uses 25 w of unregulated 28 v power.

Use of plug-in modular construction allows flexibility in the number of field-effect transistors, used as analog data gates in groups of 32 devices, or to expand memory capability by adding 256-bit memory planes.

Designers in this field also have spent considerable effort on the development of various data-compression schemes, based principally upon redundancy reduction, which would help refine the data flow from a spacecraft and add one more order of flexibility to adaptive telemetry systems.

Lockheed's efforts include development of a unit to perform data-compression functions in a spacecraft, Lockheed says it is the first such compressor so designed. The unit can accommodate a maximum of 480 data channels, according to C. M. Kortman of Lockheed, and "overall compression ratios of 32:1 can be achieved." The machine employs a mathematical form using the zero-order predictor algorithm for the redundancy reduction operation.

• **Attendance holds**—Final registration figures for the '65 WESCON fell only slightly below the predicted 35,000, considered a significant feat in this year of dwindling trade-show attendance.

There was some criticism of the fact that the technical program did not include a single panel discussion presenting military or NASA electronics needs for the future—an event normally sought after by sales and marketing specialists.

Greater reliance this year on the use of the "sidebar seminar" drew mixed reactions from attendees. Many felt that such seminars, in which up to six or eight papers were presented by the same company, were too product-oriented at the expense of technological-advance discussion.

• **Lasers discussed**—Designers of new optical radar systems should pay careful attention to the expected level of background noise to be encountered in the operational radar environment and the extent of target velocity-resolution required before selecting the type of detection system to be used.

The reward for detailed analysis of these two parameters can be a far less complex detection system for several radar applications, Stanford University Electronics Laboratories experts said at a Laser Applications seminar.

There are two basic techniques for detection of pulsed optical radar returns—the relatively straightforward energy-detection method, and the more technically sophisticated heterodyne-detection process. With the added sophistication of the latter technique also goes more complexity in the system design.

J. W. Goodman of the Stanford team discussed benefits to be gained despite the greater complexity of the heterodyne-receiver. His analysis was concerned with the comparative statistical performance of these two detection methods in the measurement of target range and velocity, assuming a pulsed radar operation with both systems.

Discussing range measurement, Goodman stated that "there exists a substantial range of background noise levels over which the energy-detection radar performs better than the heterodyne-detection radar.

"Only when relatively high false-alarm probabilities can be tolerated does the performance capability of the heterodyne-receiver exceed that of the energy-detection radar in a low-noise environment. "Evidently," he stated, "the only advantage offered by the heterodyne-receiver in range measurement is superior performance under relatively noisy conditions." ■

Technical Countdown

ELECTRONICS

GE Laser Xmtr Tested During GT-5

A field trial of a new mobile gallium-arsenide-diode communications systems quietly took place at Cape Kennedy during the countdown for *GT-5*. GE's Radio Guidance Operation, headquartered in Syracuse, N.Y., set up the small battery operated laser transmitter within press site No. 2. This prototype optical data link emits in the far infrared spectrum at 9,000 Angstroms and was used to relay color TV within the press pool. Present video cables route through the Air Force's "XY" building via a master switchboard, and the transmission is recorded on magnetic tape for near real-time evaluation of pad activities by the Air Force and NASA. The optical transmitter, which weighed less than seven pounds, produced an output beamwidth of two milliradians with a bandwidth of approximately 15 mc. The prototype demonstrated feasibility of a system eyed by the Eastern Test Range for line-of-sight video transmission throughout the Cape, officials stated after the test.

CdS Microwave Emissions Observed

Microwave emission uniformly distributed between 2 and 4 gc has been observed from n-type cadmium sulphide at Stanford University Electronics Laboratory. The radiation appears when the electron drift velocity exceeds the velocity of shear waves in the crystal. Threshold field is 900 v/cm at 300°K. Lowering the temperature reduces the threshold field. No magnetic field is required.

Digital Spectrum Analyzer Built

An audio spectrum analyzer has been implemented with a digital computer at the Systems Techniques Laboratory, Stanford University. Analog signals under investigation are converted to punched-tape form by periodic sampling with an analog-to-digital converter. An IBM 7090 or Burroughs B5500 computer then carries out the complete task of spectral analysis filtering, integration and listing of the signal's spectral distribution. In its present form, the system functions as 100 narrow-band filters, running at about 0.002 times real-time when analyzing components below 10 kc. Construction of special-purpose computers with a real-time capability of 40 kc for up to 100 filters is being investigated. Parallel machines that are compact and lightweight are envisaged for this purpose.

ASTRONOMY

It's Icarus vs. Einstein

Through the use of the asteroid Icarus, a frequent close associate of the Sun and a body due to make a close Earth approach in June, 1968, a subtle check on the accuracy of Einstein's general theory of relativity may be made, says Professor R. H. Drake of Princeton's Palmer Physical Laboratory. The concept behind the scientific study, however, requires more complex imagination. Data are being sought to determine the Sun's oblateness. Thus, scientists say, if the Sun's equatorial radius exceeds its polar radius by as little as 0.005%, the solar gravitational-field distortion would cause a significant rotation of Mercury's perihelion (or point closest to the Sun). This, they say, could account for 10% of the relativistically predicted perihelion precession of Mercury. The slow rotational change of the planet's near-solar approach is one of three principal effects explained by the presently accepted Einstein theory.

MATERIALS

Swords-into-Plowshares Dept.

Extensive research by Corning Glass Works in the development of photochromic glass for astronaut and military opthalmic protection has resulted in a recent announcement by the firm of the material's availability for general opthalmic use, including prescription lenses. The commercial glass, called Bestlite, responds to near ultraviolet light by reducing transmittance to only 75% in about 2 min. and to less than 70% in 10 min. (at 85°F). Fading or recovery time to the 85% transmittance level requires about 25 to 30 min., Corning said. Darkening occurs much faster at lower temperatures (about 58% transmittance in 2 min. at 25°F). Unaffected by standard artificial illumination, the glass has shown no fatigue effects from transmittance cycling.

GPI Reports Polymer Success

Pressing its research for development of better and more flexible high-temperature insulation for windings in rotating components, General Precision, Inc., reports initial success with synthesized polymers that so far retain their desired properties at high temperatures. Under the current effort, supported in part by the Navy's Bureau of Ships, inorganic polymers have been studied as have metallo-organic types. The full range of materials application will be studied under a recent contract extension, the firm indicates.

PROPULSION

Lockheed Fingertip Propulsion Unit To Fly

The Air Force's Aerospace Medical Research Laboratories at Wright-Patterson AFB are evaluating a fingertip-controlled personal propulsion unit designed and developed by the Lockheed-California Co. The unstabilized device is composed of a pair of hand-mounted propulsion nozzles fueled with nitrogen with fore and aft thrust control. The unit consists of a back pack containing the gas assembly, which for aircraft tests is dry nitrogen, but for spaceflight would probably be hydrogen peroxide. Some 25 flights in a KC-135 aircraft flying weightlessness parabolas are planned for the next six months.

SPACE MEDICINE

New EEG Design Tested at SAM

An encephalogram electrode development at the School of Aerospace Medicine is reported to give consistently reliable EEG data through a six-hour period with no additional attention, and produces little noise, even when tapped. Application of the electrodes requires cutting an area of hair only 6mm in diameter, and abrasion with a No. 6 dental burr to reduce skin resistance to less than 2,500 ohms at each electrode site. Design of the electrodes is such that the leads may be easily replaced, and the entire unit is resistant to accidental dislodgement.

Sperry is active in deep submergence

Naturally. Navy's Deep Submergence Program requires in-depth experience in and under the sea. Sperry is a logical choice for navigation and control responsibilities in deep submergence. Sperry has been in the forefront in sea instrumentation and navigation throughout its history. Designer of the first gyrocompass, Sperry today is producing the advanced SINS (Ships Inertial Navigation System) for the new generation of attack submarines and surface vessels. Also, Sperry is navigation Subsystem Manager for both the U.S. and U.K. Polaris programs. Engineering skills here span from the latest microcircuit sonars to specialized computers and displays — and they include the skill for close integration in both equipment and systems. **SPERRY MANAGEMENT GROUP, Sperry Gyroscope Company, Syosset, N. Y.**

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oceanology **POLICY**

Trend Is Toward Useful Applications

Congress is putting on pressure to make rapidly developing technology yield dividends; companies move into engineering phase

by William S. Beller

"THE TIME HAS COME to shift emphasis from pure oceanographic research to oceanographic projects that have useful goals," says a Navy oceanographer.

His view is reflected in (1) the flurry of bills and high interest in Congress in making oceanography pay its own way; (2) the increasing number of companies changing their emphasis from basic oceanographic research to actual exploitation of the seas; and (3) the itemization, for the first time, of the national oceanographic program in terms of national goals and problem areas.

Another impetus to the U.S. engaging in the practical aspects of the marine sciences is the possibility of losing valuable undersea resources to countries that may have first developed the means for exploiting the deep seas. This is implicit in a year-old treaty to which the U.S. is a party.

The amount of money obligated for the Fiscal 1966 national oceanographic program is $141.6 million, about a 5% rise over the previous year's. For the next three or four years, officials concerned with making the budget see only about a 20% rise in classical oceanographic efforts, an amount described as a "cost-of-living increase."

The big explosion is expected to take place in engineering applications. The Navy's deep-submergence program, for example, is seen getting tens of millions of dollars over the next several years, not only for development but also for salvage and recovery missions in the ocean, and for deep-ocean explorations for practical purposes.

- **Navy effort**—The Navy itself could use deep-sea data for plotting its ASW efforts and mine detection and laying work. This is only one facet in the Navy's oceanographic program, which is listing hard to projects in direct support of operational activities and hardware development, according to Capt. T. K. Treadwell, Navy's deputy commander for oceanography.

The Navy's unclassified program accounts for about half the money spent in the national oceanographic effort. The Navy's classified effort in oceanography is estimated at $110 million for Fiscal 1966.

In a projection through 1972, "the oceanographic spending rate is expected to reach $350 million annually, and total expenditures over the years 1962 to 1972 will have been about $2.2 billion," says Rep. Craig Hosmer (R-Calif.), member of the Joint Committee on Atomic Energy.

Oceanologists look with envy on the space agency's *Apollo* project. They would like a similar project that could catch the imagination of the public, and its tax money as well, in order to obtain support for a major oceanographic endeavor.

Interagency Committee on Oceanography (ICO)

The ICO was set up under the Federal Council for Science and Technology to coordinate the national oceanographic effort, which is pursued by 22 government agencies. It operates through seven advisory panels: research, surveys, training and manpower, oceanographic ships, instrumentation and facilities, international programs, ocean engineering.

To prepare the annual national oceanographic program, the ICO:

—Reviews current activities and planned programs of individual agencies with respect to the government's long-range objectives;

—Coordinates budget plans and recommends level of funding required for each fiscal year;

—Considers special problems that may arise in implementing the national programs and recommends solutions.

The suggested program is reviewed by the Federal Council, corrected, and subsequently issued by the President to Congress as the National Oceanographic Program.

"We should have a Lewis and Clark exploration of the continental shelf," suggests Dr. Edwin B. Shykind, associate staff director, Interagency Committee on Oceanography (ICO). The glamour of the Moon shot might not be here but the "payoffs" would be.

- **In Congress**—The hope is that Congress will pass a bill that will take oceanology in hand and give it direction. Congress is certainly interested in doing this, judging from the number of bills now in committee. Well over a dozen are under serious consideration, more than ever before.

The types of organizations proposed in these bills run from the all-embracing concept of a "wet NASA" to the present federation of agencies, considered loosely knit to some observers and well-in-hand to others.

Already passed by the upper house, Sen. Warren G. Magnuson's (D-Wash.) bill proposes a National Council on Marine Resources and Engineering Development to be established under the President. The Vice President would be chairman; members would be the Secretaries of State, Navy, Interior, Commerce, Health, Education and Welfare; and the heads of the Atomic Energy Commission and National Science Foundation.

Magnuson's is the only oceanographic bill that has passed the Senate this year; an identical bill, submitted by Rep. Dante B. Fascell (D-Fla.), is now in committee in the House.

The job of the council would be to recommend national policy in the field of marine science and engineering. To do this, the council would have a staff and advisors and would be able to spend up to $1 million a year to carry out its duties.

The proposed council membership is so auspicious it worries Robert W. Morse, ICO chairman and also Asst.

National Oceanographic Program
Agency Obligations (in $ millions)

	1964 actual	1965 estimated	1966 estimated
Department of:			
Commerce	23.3	19.9	13.3
Defense	54.6	65.1	68.1
Health, Education, and Welfare	2.9	3.5	4.4
Interior	16.5	20.0	16.9
State	0.6	0.6	0.6
Treasury	1.2	1.8	2.1
Atomic Energy Commission	3.8	4.0	4.6
National Science Foundation	19.6	19.3	30.0
Smithsonian Institution	0.6	0.9	1.7
TOTAL	123.1	135.1	141.6

Obligations for Oceanographic Effort
and Resources (in $ millions)

	FY 1964 actual	FY 1965 estimated	FY 1966 estimated
Oceanographic Effort:			
Research	56.0	68.6	78.0
Surveys	24.1	27.1	30.6
Intl. Indian Ocean Exped.	6.0	3.9	1.6
NSF Ocean Sediment Coring	—	—	5.4
Total	86.1	99.6	115.6
Oceanographic Resources:			
Ship Construction	25.5	20.7	13.4
Facilities Construction	5.1	6.0	4.4
Instrumentation and Equipment Procurement	6.4	8.8	8.2
TOTAL	37.0	35.5	26.0
TOTAL PROGRAM	123.1	135.1	141.6

Secretary of the Navy (R&D). He told Congress last month that although such a council could certainly make policy decisions, it would suffer because of the limited amount of time and effort its members could devote to deliberations. "It is better to leave oceanographic planning and coordination in the hands of the policy and operation officials who work with the oceanographic program, serve on the Interagency Committee on Oceanography, and who are thus most qualified to advise the President on its needs," he said.

Morse came out in favor of a bill aimed at providing "a comprehensive, long-range, and coordinated national program in oceanography." This bill, submitted by Rep. Alton A. Lennon (D-N.C.), chairman of the Subcommittee on Oceanography of the Merchant Marine and Fisheries Committee, calls for appointment of an Advisory Committee for Oceanography to recommend national policy. The advisory committee, together with existing Federal agencies, would participate in planning the direction of the national oceanographic program.

- **A need for haste**—The leisurely methods of the classical oceanographer, if pursued, could jeopardize tremendous national resources on the U.S. continental shelf. The surface area of the continental shelf adjacent to the United States is about 850,000 sq. mi., about one-fourth of the country's total land area. The tremendous organic and inorganic resources there remain uncharted and virtually untouched except in a haphazard way by commercial fisheries, and in a slightly more scientific way by oil companies.

The jeopardy is embodied in a recent international agreement that gives each nation the right to explore and exploit its continental shelf down to 655 ft. (200 meters), or beyond that depth in superjacent waters if the country has the ability to do it. This means that the right to exploit the natural resources of the ocean lying beyond the continental shelf would go to the nation with the technological or engineering ability to do the job.

These rights and potential rights are part of the International Convention on the Continental Shelf. It was formalized by delegates to the Law of the Sea Conference in Geneva, Switzerland, in 1958, and ratified last year by the required number of nations. This makes it a valid international treaty—and an urgent prod for the U.S. to devise means to work at extreme ocean depths.

A Congressional report commenting on this treaty emphasizes that "the rights to exploit resources beyond the shelf will go to those nations which first develop and use the instruments, equipment and technologies necessary to exploit them."

- **Whence the impetus?**—The initiative to exploit the shelf can "logically" come from the new National Academy of Engineering, the Government and industry, according to Capt. Treadwell.

Oceanographic Research
Agencies Supporting the Research Effort
FY 1966

Office of Naval Research	$24,858,000
National Science Foundation	18,300,000
Bureau of Commercial Fisheries	12,450,000
Atomic Energy Commission	4,583,000
Bureau of Ships (Navy)	3,875,000
Naval Oceanographic Office	3,016,000
Public Health Service	2,559,000
Smithsonian Institution	1,689,000
Bureau of Naval Weapons	1,627,000
Army Corps of Engineers	1,333,000
Weather Bureau	789,000
Geological Survey	740,000
Coast & Geodetic Survey	590,000
Department of State	586,000
Office of Education	390,000
Bureau of Sport Fisheries & Wildlife	382,000
Bureau of Mines	153,000
Coast Guard	61,000
Maritime Administration	50,000
TOTAL	$78,031,000

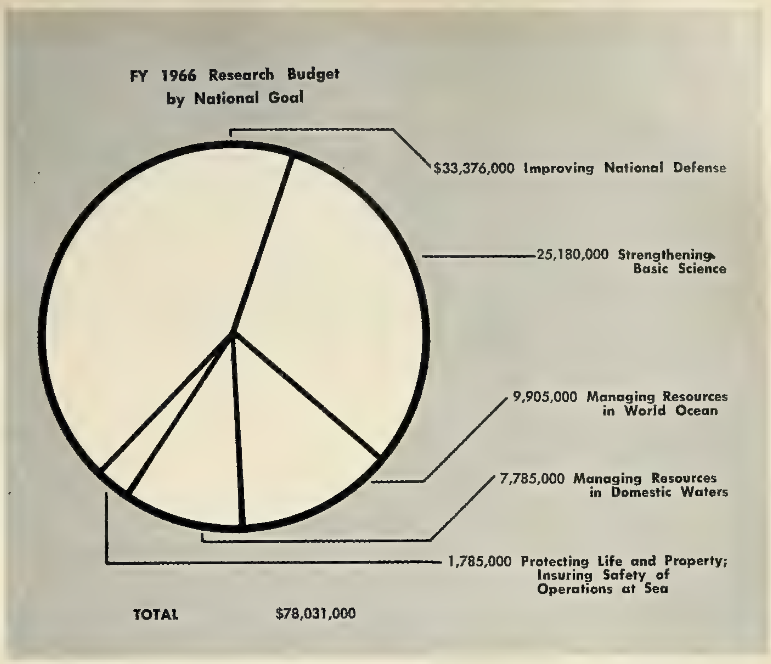
He pointed out that the first panel the Engineering Academy set up was on ocean engineering, denoting the subject's "overriding importance." He said that this may result in ocean engineering getting the same push the National Academy of Sciences gave to scientific oceanography several years ago.

Treadwell believes industry itself has not taken a recent "good hard look" to see what the oceans have to offer. He admits that industry ventures must offer commercial profit, but he maintains that industry will never know the situation unless it investigates.

The naval officer stressed that, like industry, his service wants to use the oceans—and has been doing this. As an example, the Navy this spring went into a three-year, $12-million oceanographic and geophysical survey of the world's oceans. The work is designed "to enhance our combat readiness in all branches of naval warfare, but will particularly support underseas and antisubmarine warfare programs."

This is the first major survey effort the Navy has entrusted to private industry and therefore "represents a vote of confidence in the increasing maturity and reliability of firms engaged in ocean technology," said Treadwell. He added that through the two prime contractors —Alpine Geophysical Associates, Inc., Norwood, N.J., and Texas Instruments, Inc., Dallas—"a substantial support of commercial oceanography and our merchant marine will be made."

- **Ocean uses**—The economics of tapping the ocean for certain minerals may not be favorable now, but under wartime conditions might be critical. The country's supply of manganese, for instance, is almost entirely imported, chiefly from Africa. In an emergency, this supply could be cut off, with the country having to resort either to substitutes or ocean exploitation. Other military as well as commercial needs might be anticipated by ocean resources, and their exploitation encouraged by


FY 1966 Research Budget by National Goal

industry alone or in collaboration with government.

Private industry is already supporting efforts to develop practical methods for undersea mining. In a unique arrangement, each of three major companies is providing the Bureau of Mines, Department of the Interior, with funds and engineering manpower for research and development work on marine mining systems. In turn, "the Bureau is supplying program leadership, specialized scientific knowledge, and physical facilities for research," says a Bureau release.

This reverses the familiar situation in which the Federal government foots at least part of an endeavor in which it has an interest.

In July, Merritt-Chapman & Scott Corp., New York City, a well-known engineering construction firm, followed the lead of Lockheed Missiles & Space Co., Sunnyvale, Calif., and International Minerals & Chemical Corp., Skokie, Ill., who earlier entered into cooperative agreements with the Bureau.

The agreements provide that additional funds may be supplied by the industrial cooperators as developments occur. The program's goal is to find practical ways for recovering valuable mineral raw materials from the kinds of deposits already known to exist on the floors of the world's oceans.

"Development work will range from efforts to find construction materials that can withstand the effects of ocean environments to the conception, design, fabrication, and testing of platforms, undersea operating systems and equipment, and scientific instruments."

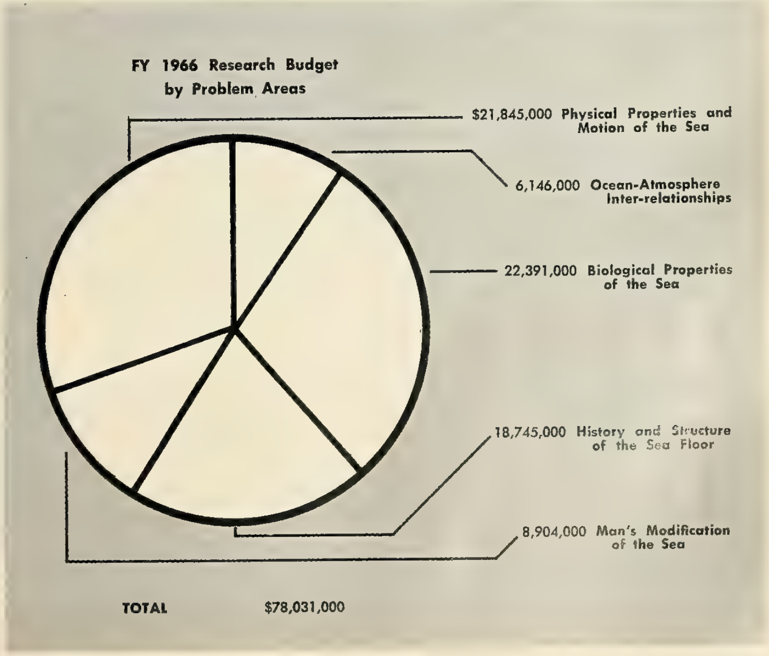
Some segments of industry may have the means almost at hand for exploiting the oceans to better advantage. Treadwell thinks that the shipping interests, even now, seldom think of the ocean as a separate environment and do not try to take advantage of its unique characteristics. Commercial fishermen, too, are not doing as much as they can, says Treadwell. He adds that their Russian counterparts listen well to scientific advice, use it, and are thereby able to fish all over the world with notable success.

- **Fresh water potential**—A possible payoff to shipping interests could be heralded by the work of Dr. Vincent E. Noble, a University of Michigan scientist.

He sees the possibility that the amount of winter ice cover on the Great Lakes can be predicted during the fall by applying knowledge of deep-water temperatures. The ability to predict ice cover "could extend the shipping season and reduce shipping costs by permitting the use of fewer ships for longer periods," he said. This could amount to substantial savings since the tonnage of raw materials and goods shipped through the Great Lakes during an eight-month navigable season surpasses that of most other shipping lanes in the world.

The technology derived from the space effort is seen feeding the oceanographic effort. Typical fallout to oceanography extends from using radioisotopes in buoys to generating artificial environments in manned undersea facilities.

Like the space program, the oceanographic program is exploring uncharted territories. Unlike the space explorers, the agencies concerned with oceanography have grown impatient with the lack of practical results proportional to the time investment made. Hence the shift in oceanography from basic research into more profitable fields. ■


FY 1966 Research Budget by Problem Areas

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GENERAL DYNAMICS

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Hull Development Paces Exploration

Need for 100% safety and true buoyancy must be met before deep-diving vessels are operational; Navy provides funding spur

by John F. Judge

HULL MATERIALS and hull structures are the major restrictions binding the rapid development and usage of the oceans and their floors.

The limitation plagues both military and commercial interests. Approximately 21 manned vessels are under test or in their construction phases for underwater applications at various depths—but none are yet truly operational vehicles. Some have been designed merely to get down and look.

The current state of the art in materials and design permits positive buoyant hulls of useful weight displacement ratios to be built only for modest depths. The really deep manned probes have been heavier than water.

The federal interest in oceanology is now spread through almost every agency, including the Agriculture Dept. But the major funds and the real drive to be able to function realistically at any depth is in the Navy.

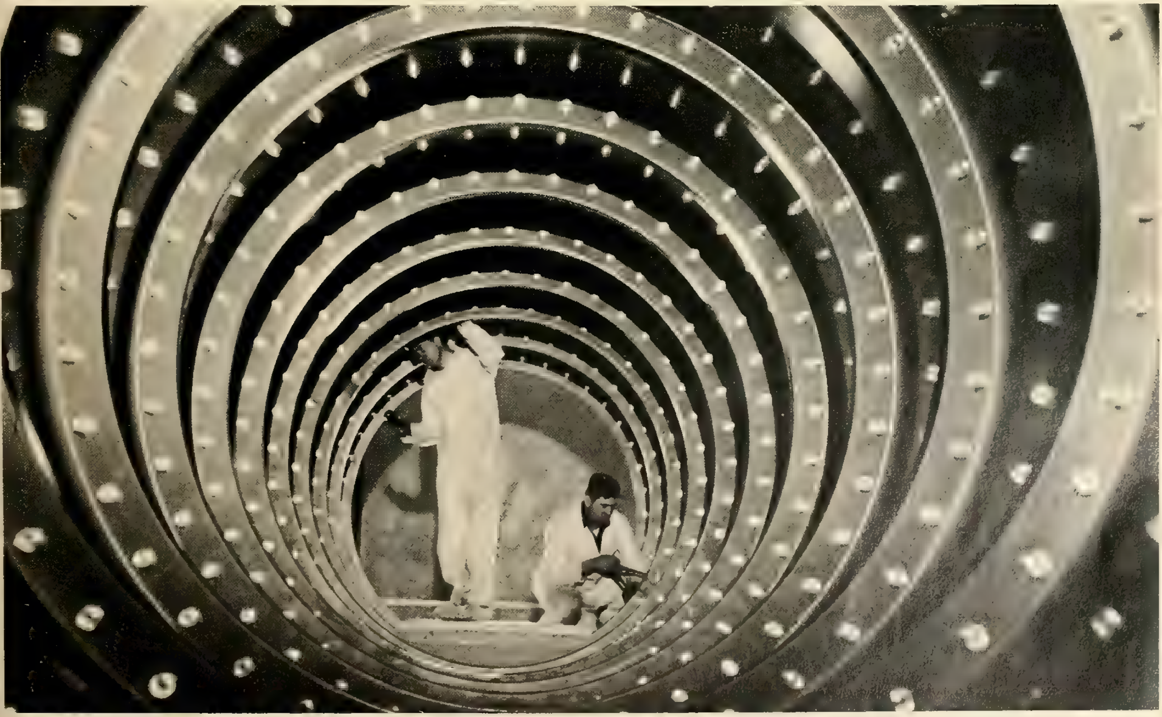
Historically hard to convince and reluctant to commit new technologies to its primary military mission, the Navy is nevertheless moving quickly into the depths. The U.S. Navy now has undisputed control of the world's oceans—yet this control extends to less than 20% of the total area involved.

- **Changing technology**—With the advent of the first true submersibles—the nuclear submarine—and its mating to missile technology in the *Polaris* Fleet Ballistic Missile program, the service is familiar with both traditional marine problems and the vast ability of the aerospace industry.

Dr. John P. Craven, chief scientist, Special Projects Office (SPO), says the current coalescence of emphasis on deep ocean technology by Navy, industry and other government agencies is producing a transition from a surface-oriented technology to one largely submerged.

Craven, taking the long view, says this transition process will be characterized for a time by increasing com-

THE PRESSURE HULL of the Reynolds International Aluminaut consists of 11 forged 40-in. cylinders and two hemispherical heads of aluminum alloy 7079-T6. The hull is entirely bolted and is some 6½ in. thick. The Navy Special Projects Office is interested in the data gathered on the performance of the 15,000-ft.-depth submersible, but has eliminated aluminum from hull considerations for rescue and deep-search submersibles. Glass is one of the leading candidates for such deep-sea work.



plexity. This will proceed to a point at which those "simplicities beyond complexities" are recognized and realized. This is a visible trend in the history of every modern technology.

At the moment, the "development dilemma," as Craven calls it, is marked by the development potential for deep-submergence materials being inversely related to the present state of the art in design, fabrication, inspection and test.

SPO has the responsibility for the Navy's deep-submergence development and Craven told MISSILES AND ROCKETS that if he and his office were willing to accept (and they are not) the vehicle losses corresponding to that in present aircraft, the Navy would have a manned deep submersible in the near future at a very low cost. But safety is the primary consideration and the technology must be directed to meet objectives based on 100% safety.

- **Eternal compromise**—Craven says that higher strength-to-weight ratios are obtained by sacrificing toughness—yet toughness has allowed the use of relatively inexact design, test and inspection procedures.

The traditional rule-of-thumb approach to the design of heavy structures for the ductile metals has been to calculate nominal stresses and then insure that these stresses were below the yield strength of the material.

High local stresses in tough materials resulted in local deformations that resolved the stress distribution problems. Craven says some spectacular structural failures over the past several decades illustrate the shortcoming of this procedure—the inability of the material to deform at low temperature.

The toughness behavior of steels over the range of operational temperatures is well known and characterized by the Charpy V-notch test. The data is at hand and the designer has been able to specify, in addition to strength, a minimum Charpy impact and temperature requirement sensibly below the service temperature.

Craven restated the importance of the impact values at the start and end of metal transition temperatures. It has been assumed that a fabricated structure contains small flaws that escape detection, or that such small flaws could be initiated in a complex structure in a corrosive environment.

To assure integrity of the hull structure, Craven says that the rate of crack propagation must be small and that fatigue cracks must not initiate fast fracture. This insurance has been obtained by specifying high minimum Charpy impact level.

Satisfactory values have been obtained for HY80 steels, for HY100 and for HY140 steels. Beyond this level, says Craven, it is wishful thinking to believe that adherence to such imprecise criteria can be maintained.

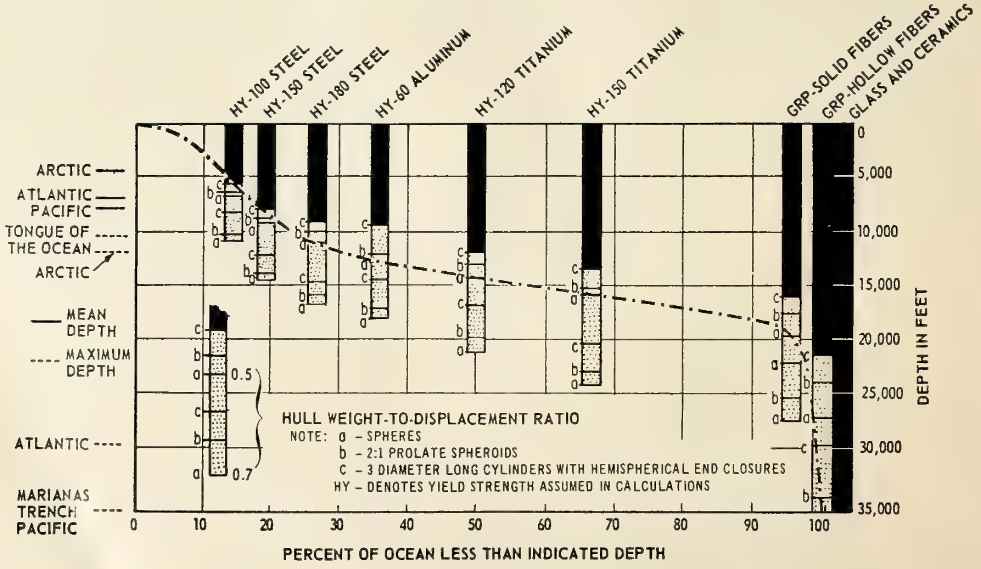
The tough metallics are only one of the four classes of materials considered by the Navy—and everyone else—as applicable to deep-submergence programs. The others are the brittle nonmetallics, the fibrous composites and the ceramics and glasses.

- **Steel limits**—The designer's most desirable direction of extension is toward the high-strength, lighweight, tough metallics. Craven says that in this instance, test procedures are adequate, acceptance criteria are available, allowable crack size is within inspection tolerances and catastrophic failures do not occur.

Unfortunately, says Craven, despite numerous formulation attempts, the quenched and tempered steels become increasingly brittle at higher strength levels. Their use places a heavy burden on quality control, non-destructive test and inspection.

Work at the Applied Physics Laboratory, Johns Hopkins University, in reviewing problems associated with modern NDT techniques has shown that high-density radiographs can be evaluated to differentiate between "aligned

OPERATING depth potential for hulls of various materials prepared by Martin A. Krenzke, head, design analysis, submarine structures division, David Taylor Model Basin. Depths were calculated for near-perfect, initially stress-free hulls with an assumed safety factor of 1.5 on static collapse depth. A maximum stress of 50,000 psi at operating depth was specified for the glass-reinforced plastic shells. The solid portion of the bars above the depth distribution line corresponds to those hulls with a weight/displacement ratio of 0.5 and the bottom extremity represents hulls with a weight/displacement ratio of 0.7.



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RANGE DATA TRANSMISSION People are needed to work on range data transmission. Particular work areas include digital data transmission, systems analysis and testing. Experience with switching systems, modulation and information theory, and coding is desired.

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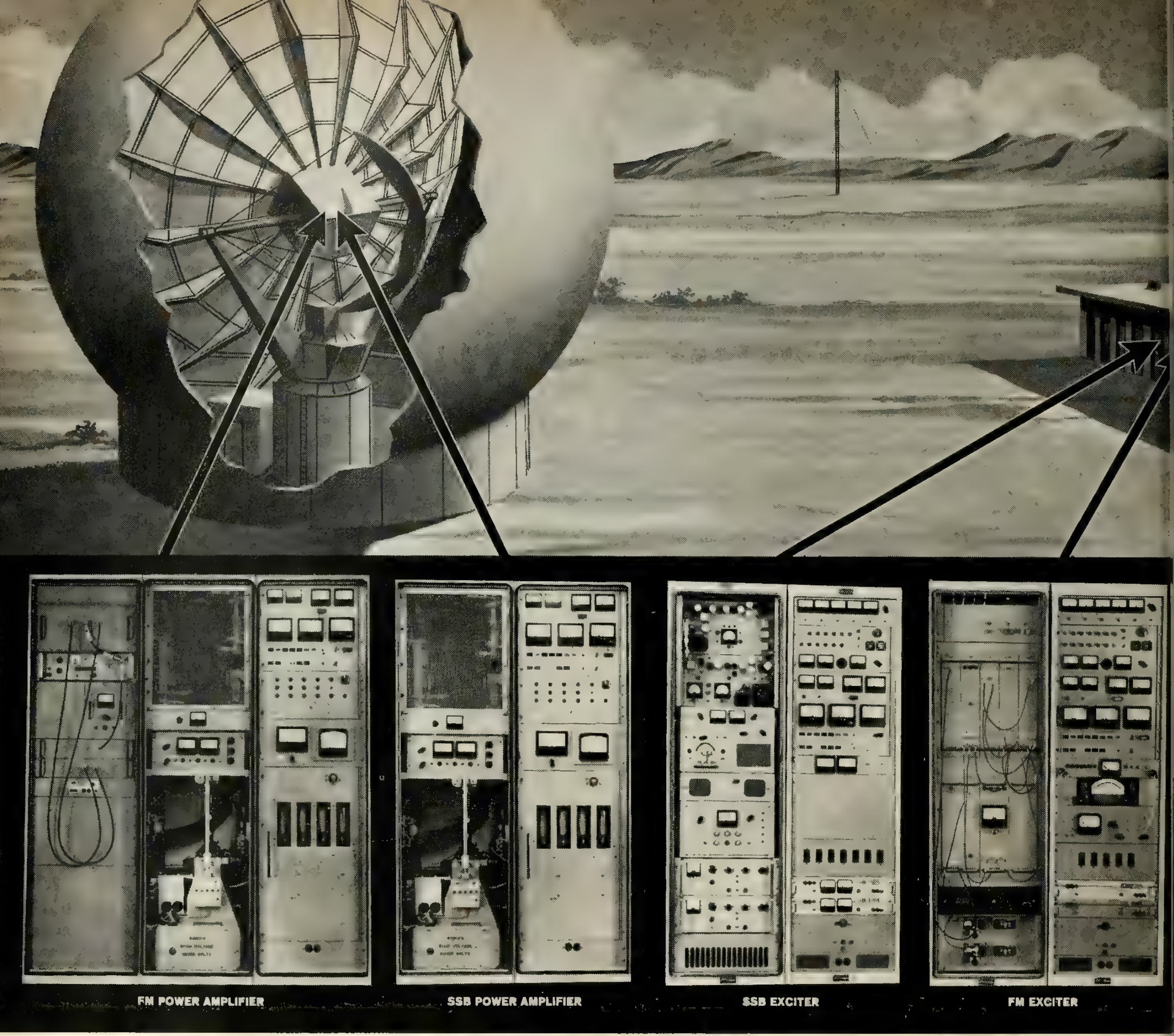

Raytheon supplies communications heart for advanced technological satellite program

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Raytheon has provided units and associated engineering services to NASA for installations in California, North Carolina and Australia, and to the Canadian Department of Transport for installation at Halifax, N. S. *Raytheon Company, Communications and Data Processing Operation, Norwood, Mass.*

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porosity, root oxidation and upper slag"—which do not significantly affect the fatigue properties of joints—as compared with flaws and inclusions, which have a direct affect.

In addition, says Craven, the Naval Research Laboratory has also developed a fatigue test in which a carefully controlled initial pit is made in the specimen in order to accurately relate flaw size to fatigue life.

Craven says that if the development choice in deep submersibles is for higher-strength quench-and-tempered steels, extensive refinement of ultrasonic, dye penetrant, Magnaflux and radiographic inspection techniques must be undertaken with a view toward relating inspection results to the physical phenomena affecting fatigue life of fabricated vehicles. New techniques would also be needed.

- **Maraging steels**—Craven points to the alternate ferrous category—maraging steels. The promise here, he says, is materials with toughness at high strength levels, tolerating a large amount of joint imperfections or flaw size before degradation in fatigue properties occurs.

Maraging steels attain their strength through a precipitation hardening reaction following a solution treatment. The product of the solution treatment is a soft martensitic alloy amenable to forming, machining and welding. After fabrication, the structure is aged in the 850°-to-950°-F range to develop strength.

That this family of nickel alloy steels can handle tough missions is being demonstrated in the large solid-rocket motor work now being done. In addition to this work, a 1/5 scale pressure capsule model—a welded bisphere of maraging steel—has been successfully pressure-cycled in water 10,000 times at 2,700 psi.

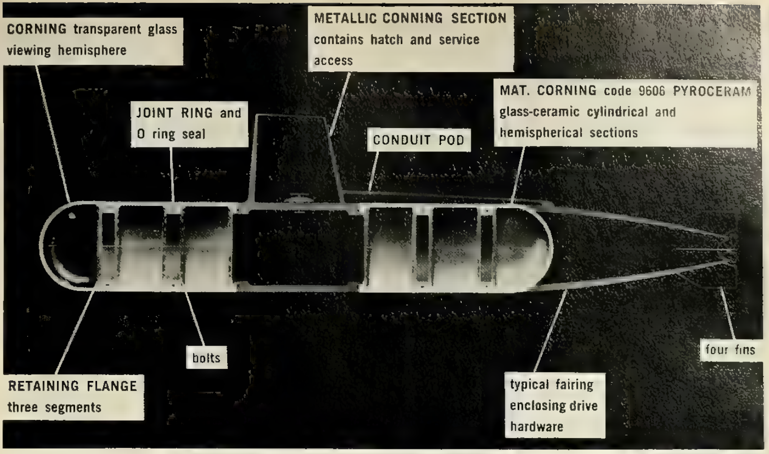
Craven notes that maraging steels appear to be sensitive to stress corrosion at the 200,000-psi yield strength level, but more data is needed to fully define the stress corrosion characteristics.

Since a number of firms are working with the maraging steels at high strength levels and in thick sections, Craven thinks their application to naval vehicles may come about without extensive Government effort.

The Navy's long-range target is operational ability at 20,000-ft. depths. Craven does not expect developments in any of the steels to meet the hull requirements of such vehicles.

- **Titanium potential**—The next most attractive metal is titanium, and current development efforts are centered on the fabrication techniques for moderate strength levels and thick sections.

The trouble with titanium is the recent discovery by experts at both the Navy's David Taylor Model Basin and the Applied Physics Lab that the Ti721 alloy is highly susceptible to stress corrosion at high tensile levels.


CORNING transparent glass viewing hemisphere
METALLIC CONNING SECTION contains hatch and service access
MAT. CORNING code 9606 PYROCERAM glass-ceramic cylindrical and hemispherical sections
JOINT RING and O ring seal
CONDUIT POD
bolts
four fins
RETAINING FLANGE three segments
typical fairing enclosing drive hardware

ENGINEERS at Corning Glass Works designed this 64-ft.-long, 8-ft.-wide glass submersible strictly as an exercise to stimulate discussion of the advantages of massive glass for underwater structures. Various types of joints have been designed for the sub-section interfaces. Corning has perfected breech-lock joint designs for smaller submersibles.

Craven says this knowledge demands a new look at titanium alloys and weldments before these materials can be applied to deep submersibles.

"Even then," says Craven, "fabrication techniques which require inert atmospheres and involve thick sections are an art at present, and the considerable skill required and high costs are limitations in choosing this material for development."

An alternative to alpha, alpha beta or beta alloys of titanium is the intermetallic compound nitinol, under development by the Naval Ordnance Lab. This compound is an intermetallic alloy of titanium and nickel at the stochiometric ratio of 55-45. It appears to be highly ductile and tough at high strength levels and also to be corrosion resistant.

Craven says the other metallics that are more promising from a weight displacement ratio, such as aluminum and beryllium, no longer figure in the "development dilemma" of the Special Projects Office because of a decision not to consider them as alternatives.

In spite of extensive experience in *Polaris* system components, Craven claims that beryllium presents problems of cost, fabrication and toxicity which are "well nigh insurmountable as compared with other alternatives."

Even though aluminum has a long development history and comprises the hull of the Reynolds International Aluminaut, it must still be characterized as requiring careful and continuous attention—in fabrication and throughout the operational life of the structure.

The SPO is interested in the inspection techniques for continuous surveillance of the Aluminaut's hull, and if the choice for development were made in this direction, much could be learned from the vehicle. But Craven says extensive development of alloys, test procedures and methods for protection from the environment would still be required.

- **Composites attractive**—The next logical candidates for deep vehicle development are the glass fibers as reinforcements for resin matrices. Craven says the significant advantages of these composites over other materials are availability and the existence of the technology for fabricating large, thick-wall structures.

But the design must avoid cut filaments for both joints and penetrations in fabricating a pressure hull. Reinforcements around cut-outs are inefficient and expose cut filaments to environmental degradation.

Metal parts will be required for hatches and penetrations and the combination of metal and glass-wound sections in structures is state of the art for internal pressure vessels.

But the development of filament-wound structures for deep submergence poses different problems than those solved in the rocket motor case area. Fatigue life, water absorption and buckling strength are included in the development problems.

The two most critical areas of uncertainty in glass-reinforced plastics are fatigue and design concepts. J. A. Kies of the Naval Research Lab says it is axiomatic in metals that loss as measured by ordinary static strength after fatigue cycling is always associated with the growth of one or more fatigue cracks.

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In addition, the damage is not necessarily detectable by a strength measurement throughout the material, but may only be detectable in a sample containing the crack or cracks.

But in glass-reinforced plastics, it is not yet known what to look for as internal changes, specifically and positively identified with fatigue damage as measured by loss in static collapse strength.

Kies has pointed out that the work on small glass-reinforced structures has not allowed for the degrading effect of scaling up the size of the model and the wall thickness. Experience leads Kies to expect the strength to degrade in percentage at about 1/20 the rate at which the volume increases.

- **Glass fiber support**—Kies is a strong proponent of glass fiber structures in many undersea areas other than the 20,000-ft.-deep submersible region. For this reason, the NRL scientist has called for long-range development and fundamental research into the various aspects of glass-reinforced plastics—alone and in conjunction with metals in hull fabrication.

Glass fiber-reinforced plastics call for an entirely different approach on the part of the designer and fabricator. As pointed out by N. E. Promisel, materials chief, Navy Bureau of Weapons, such materials move from raw stock to finished part without any of the classical middle steps. Kies says the importance of refined design and structural concepts that treat glass-reinforced plastics as a special material cannot be overemphasized. The structural configuration is based on the peculiarities of the material.

Some of the characteristics of glass-reinforced plastics that call for special consideration by the structures, design and fabrication experts are listed by Kies.

A representative sampling includes: shear and tensile cracking in resin and along resin-glass interfaces; equal tensioning of fibers; port reinforcement; lay-up patterns; moisture effects; fiber properties; mechanical damage; glass finishes and the glass-resin bond; test methods, destructive and non-destructive; processing variables, including resin porosity; bonded joints and seals.

These are only some of the many areas in which current information is not sufficient to apply to submersibles. Industry and Government experts in materials for these applications are extremely realistic. There are few who expect complete solutions to any of these problem areas. But there are many who are confident that increased effort will lead to usable manned and unmanned vehicles embodying structural concepts never before used by any seafarer.

More than a year ago, Kies outlined several areas considered radical—and needing research—in deep-diving vehicles. He covered metal composites, metal-plus-glass-reinforced composites, photoelastic models for experimental stress analysis, sandwiches and shell support systems incorporating glass-reinforced plastics encapsulated in metals, and other spaced-wall constructions.

- **Massive glass**—The most unlikely candidate material for operational underwater use under consideration a few years ago by any branch of the Navy and most of industry was solid glass.

In 1965, this material, in various forms and shapes, is proving to be the only alternative to glass-reinforced plastics for 20,000-ft. depths.

The Navy's SPO has established the general specifications for a deep search vehicle—tentatively due for initiation of fabrication by Jan. 1, 1968. This vehicle will have an operating depth of 20,000 ft. and a collapse depth of 30,000 ft. It will cruise for 4 hours at 5 knots or 10 hours at 4 knots. Its crew will consist of two operators and two relief men or observers.

The vehicle will be 9 ft. in diameter and 40 ft. long and will weigh 50,000 lbs. The pressure hull will, in all probability, be a sphere and it would appear from present collapse depth-weight/displacement materials charts that the only materials usable are solid glass and glass-reinforced plastics.

If glass-fiber-reinforced plastic is used as a base, says Craven, metals would have to have the strengths shown in the table to be competitive.

- **Marrying glass to metal**—Craven feels the tentative direction of design for 20,000-ft.-depth manned search vehicles is toward titanium supplemented by syntactic foams or unmanned glass capsules for bouyancy. The hardware fabrication dates now slated for 1968 are too near for adequate development of the glass and glass-reinforced plastic vehicles.

Jerry D. Stachiw, now with the U.S.

Comparative Strengths of Proposed Hull Materials

	Density (lbs./cu. in.)	Required Strength (psi)	Available Strength (psi)
GRP	0.075	150,000	150,000
Ti (6A1–4V)	0.170	339,000	130,000
Steel	0.282	564,000	250,000
Bulk glass	0.089	176,000	300,000

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Naval Civil Engineering Lab, Port Hueneme, Calif., and H. A. Perry, Naval Ordnance Lab, White Oak, Md., are generally regarded as the forerunners in developing glass and ceramic submersible shells.

The work is still in its infancy, even though small glass capsules are being built and tested for 20,000-ft.-plus depths. Craven says that completely different concepts of design, inspection and testing are required before manned vehicles can be safely constructed, but the promise of the material seems to warrant the undertaking.

While glass has a very low tensile strength, its compressive strength is extremely high. Glass usually fails in tension, but high compressive stresses imposed on a glass vehicle at great depths must be overcome before failure occurs.

Just how high these forces must be is illustrated by a recent test conducted by engineers at the Benthos Co., North Falmouth, Mass., on basketball-sized underwater glass floats made by Corning Glass Works.

A 10-in.-dia. sphere was compressed in a water pressure tank simulating a depth of more than 18,000 ft. A pressure-powered, hardened steel pin was driven at the glass with a force of more than 3,000 lbs. A smear of stainless steel on the sphere's surface and a broken steel pin resulted.

Other tests at Southwest Research Institute, San Antonio, Tex., showed that the peak dynamic pressure generated by underwater explosions impinging on capsules had to reach 23,000 psi before fracture of the Pyroceram and alumina oxide shells occurred at 12,500-ft. depths.

In addition, Stachiw has reported that fluctuations from 80-90% critical pressure to zero pressure for a duration of 3,000 cycles did not cause Pyroceram shells to fail. This indicates a resistance to compressive fatigue stresses at least several magnitudes higher than that of glass-fiber epoxy laminates.

- **Limitations of glass**—Craven cites toughness as one of the drawbacks to using glass in manned vehicles. The problem, he says, is to design a composite hull using other materials to furnish the toughness.

A second serious problem is the design of penetrations and hatches in such a glass hull. Craven is referring primarily to non-electrical openings, since electrical penetrations through glass is now state of the art.

Kies outlines some equally vexatious long-range problems. How to approach the theoretical compressive strength as used in a structure by controlling flaws in the material and the question of the magnitudes of thermal and residual stresses under world-wide operating conditions are some examples. ■

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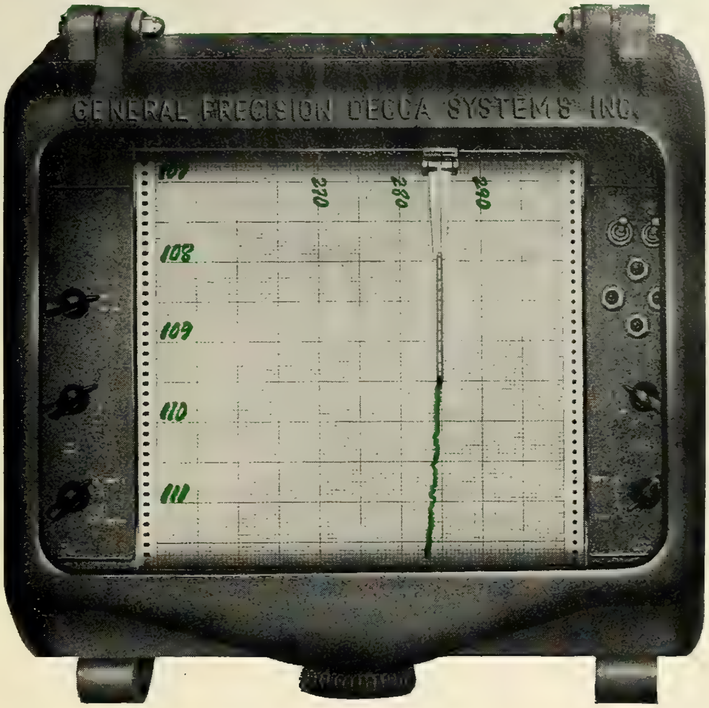

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Lack of Definition Slows Progress

Buyers' chief need is for more reliability, but manufacturers are awaiting clearer picture of market before investing further

by Michael Getler

DESPITE A LARGE DOSE of promises in the past few years that there would be an enormous expansion in oceanographic instrumentation, the oceanographers are still looking for the instruments and the instrument makers are still trying to find the market.

In the opinion of many long-time practitioners in the field, both in and out of government, several problems, basic to both the need for new and better instruments and the economics of producing them, must be tackled before the gap can be closed.

For the users, the major need is for instruments that are far more reliable than existing devices and are able to operate in the ocean environment for longer periods, at greater depths, and with better accuracies. Also wanted are instruments easier to handle and recover, and adaptable to the growing requirement for digital data processing for continuous on-board analysis.

For the manufacturers, the primary problem is to find equipments for which the market extends beyond the small numbers involved in special-purpose requirements of government or research institutes. Oceanography requires large numbers of instruments, many of them of similar types, but virtually no standardization has been imposed.

The result, especially in the area of research, is scores of instruments with slightly differing performance or operational characteristics. Even within the Navy, certainly the largest potential market for mass-produced instruments, there is little standardization.

Many observers feel that unless there is a strong indication that the market will be large enough to amortize new development costs, the manufacturers will not pump major in-house money into advanced R&D.

While standardization may have some advantages in terms of building up the market potential for certain instruments, the choice of these instruments must be a careful one. Standardizing too quickly within a rapidly changing field such as oceanology can be dangerous and may stifle new development.

- **Reliability reward**—Without question, the biggest across-the-board need in ocean instruments is better reliability. Success here will feed on itself. Instruments able to operate unattended for periods of a year or more, remain calibrated, and endure rough handling and an even rougher environment will set in motion many of the truly expansive programs now envisioned.

The techniques being called upon to accomplish this are directly descended from the space program. Unlike the space effort, however, oceanography does not yet offer the economic motivation to make the effort seem worthwhile.

How the user reacts to the current state of reliability is illustrated by Rear Adm. Denys W. Knoll, the Oceanographer of the U.S. Navy. Knoll reports that "our experience at the U.S. Naval Oceanographic Office (NAVOCEANO) with recent instrument developments is not good. Out of $4 million of instrumentation purchased, 37% would not work when delivered, and 75% did not meet manufacturer's specifications."

Knoll says that "instruments needed for routine use seem to lack requisite quality assurance, reliability, and maintainability, from which one might conclude that, in the urgency of competition, these instruments are being declared operational before their time."

"Operational reliability," says staff scientist Allyn Vine of Woods Hole Oceanographic Institute (WHOI), "is now an extremely slow process. To improve it requires a nucleus of people on each instrument that build it, test it, debug it, and then build another model. What this means is a new and comprehensive instrument procurement process.

FIRST OF TWO prototype long-range telemetry buoys under development for ONR is towed to position off Florida coast. It is hoped that the system will allow data transmission from unattended instruments to stations 2,500 miles away.

"Laboratories and institutes now tend to use their own research instruments rather than those developed and built by industry. Industry on the whole does not have ships with which to test these devices properly, and present contracts don't permit it. We need continuing-type contracts to bridge this feedback gap. There is now too much time spent trying to defend an instrument that is no darn good; too many people building marginal instruments and not enough building good ones," he states. "The need is for arrangements where lab and manufacturer can work very closely. It is harder for a company to debug an instrument than for an institute, but the institute scientists don't know much about production.

"Dollars aren't the only ingredient," Vine adds, "the firms must want to do it. The French effort in submersibles is an example of how a small-dollar effort run efficiently can get results."

● **More problems**—Another factor complicating reliability has been the tendency, as Adm. Knoll points out, for units designed primarily for research to gain acceptance eventually for oceanographic survey and development projects. "In general," says the admiral, "this is uneconomical and the instruments are not sufficiently rugged for the task."

A further complication in reliability analysis is the incredibly complex job of figuring out the handling stresses to which instruments are subjected aboard ship. Says one specialist at A. D. Little Co.: "The sailor on deck in sea-state three handling an ocean instrument is a very difficult item to figure."

"There is also the problem," says Vine, "of how special-purpose you make an instrument. There needs to be more discussion on this point between the users, instrument designers, and industry to find out if there are not one or two things that are good enough for several needs that we can move ahead with in standard production."

● **Budget fluctuation**—For Fiscal Year 1966, the U.S. National Oceanographic Program budget, comprised of requests by nine government departments or agencies that carry on programs in this area, estimates that some $8,202,000 will be spent for instrumentation. More than half of this will be spent by Navy's Oceanographic Office and Office of Naval Research (ONR).

The FY '66 figures actually represent a decline in instrumentation expenditures from the FY '65 estimates, which are $8,767,000. The biggest jump in government expenditures for instrumentation came in the FY 1964-65 period, when the budget increased from $6,386,000.

Despite the relatively small amounts being spent in this area, the current funding includes work on several programs which, when coupled with projects being funded in other areas, will no doubt point the way to both better technology and a better, more clearly defined market place.

From the scores of separate efforts being carried forward both in and out of government, the most important trends appear to be:

—Development of low-cost, expendable instruments.

—Standardization of specifications for a small but steadily increasing number of primarily survey instruments.

—Introduction on a wide scale of solid-state and microelectronic circuitry; also, much greater attention paid to mechanical design on instruments where moving parts are used.

—Design of all new sea-going oceanographic vessels to include highly integrated electronic instrument subsystems.

—Heavy expansion in the use of digital output sensors coupled with shipboard data-processing systems and standard-format data submission.

—A rapid increase in plans for use of satellite-monitored ocean instruments; also, increased use of shipboard navigation systems able to use navigation satellites for highly accurate survey vessel fixes.

—A possible increase in the need for new instruments to operate in the immediate air-sea interface area.

—Attempts to achieve a major improvement in marine biological instruments.

—An expansion in the use of free-falling instruments and in more flexible recall methods for recoverable instruments.

CHART SHOWS performance of shipboard survey system being installed on AGS-26, intended to be prototype for future.

		Measurement Accuracy			Sampling Rate		Recording Display		
Variable	**Mode**	**Analog**	**Digital**	**Range**	**Analog**	**Digital**	**Analog**	**Digital**	**Other Features**
Bathymetric Depth	Underway (0-15 knots)	One part in 3,000	Same	6,000 ftm	One sounding/sec	Programmable 2 sec to 1 min	Graphic recorder	In-line numerical	Four modes utilizing hull-mounted, towed and stabilized transducers
Magnetic Intensity	Underway (0-15 knots)	± 1 gamma	Same	20,000 to 100,000 total gammas	Programmable 2 sec; 10 sec; 30 sec; 1 min; 5 min.	Same	Graphic recorder	In-line numerical	
Gravity	Underway (0-15 knots)	± 2 milligal. Less than 1 milligal/month drift rate	Same	977 to 984 gals	Continuous	Programmable 1 to 15 sec	Graphic recorder	In-line numerical	
Surface Temperature	Underway (0-15 knots)	0.05°C	0.05°C	−2°C to +40°C	Continuous	Programmable 2 sec to 5 min	Graphic recorder	In-line numerical	
Seismic Reflection	Underway (4 to 6 knots)	½ wave length of frequency w/ velocity of 5000 ft/sec		Penetration of 4,000 ft in water depth of 15,000 ft	Continuous		Graphic recorder		4-element line source transducers; playback equipment identical to shipboard recording for on-shore analysis
Seawater Temperature	On-Station	± 0.1°C	0.05°C	−2°C to +40°C	Continuous	Programmable 2 sec to 5 min.	Graphic recorder	In-line numerical	Analog data for bathymetric depth and seismic variables recorded on precision helical-type graphic recorders
Sound Velocity	On-Station	± 0.3 meters/sec	± 0.3 meters/sec	1,400 to 1,6000 meters/sec	Continuous	Programmable 2 sec to 1 min.	Graphic recorder	In-line numerical	
Ambient Light (underwater)	On-Station	± 3 per cent of each decade	Same	0-10,000 Lumens	Continuous	Programmable 2 sec to 1 min.	Graphic recorder	In-line numerical	Other underway variable data recorded on Honeywell single-pen strip chart recorders
Ambient Light (surface) same									All on-station variable data recorded on two Brush multichannel graphic recorders
Depth	On-Station	± 0.4 per cent of each range	± 0.4 per cent	0-500 meters 0-6,100 "	Continuous	Programmable 2 sec to 1 min.	Graphic recorder	In-line numerical	
Salinity	On-Station	± 0.02°/oo	± 0.02°/oo	30-40°/oo	Continuous	Programmable 2 sec	Graphic recorder	In-line numerical	The digital in-line numerical data presented by nixie display on central display panel

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Following is a rundown on how these trends are apt to develop and what they will mean.

- **Expendable instruments**—Certainly these are the best bet for a new class of instruments which can be mass-produced and sold at least to the biggest customer, the Navy, and possibly to several others (M/R, April 5, p. 37). Several of these devices are already on the market, but the big Navy buy is still not yet decided. The initial focus is on the widely used bathythermograph (BT).

However, studies are also in progress to extend this concept into other instruments such as sound-velocity meters, salinometers, and penetrometers. Some of these, such as the sound-velocity meter, will require rather complex circuitry which could hamper low-cost production.

The BT concept is based upon use of solid-state or microminiature electronics, mass-produced for an instrument which is linked by a hardwire telemetry hook-up to the surface ship. Though data collection via hardware may result in some loss of accuracy in comparison with recoverable devices, the expendable BT will have several important advantages in cost and in the way it is used.

By mass-producing these, the Navy believes it can get instruments which cost on the order of $12-15 each. Consultants in this field estimate that the Navy within two or three years will be purchasing expendable BT's for both ocean survey and tactical ASW-related applications at rates of about 150,000-200,000 per year.

Removing the recovery requirement will make it possible to use the instruments far more often from so-called "ships of opportunity"—often commercial or merchant vessels, not part of the oceanographic fleet, from which measurements are made. These vessels will not have to slow down to recover the BT's and would not need extensive deck handling equipment. Use of standardized BT's would also go a long way towards easing the backlog of data taken by current BT's which arrive in a variety of different data formats.

The Bureau of Ships bought a small number of these units from at least three firms—the Bissett-Berman Corp., Francis Associates, and a Packard-Electric unit from General Motors' Defense Research Lab—for test and evaluation.

Oddly enough, some observers believe that the new BT's would be used in a tactical role primarily with data recorders providing an analog trace—which is what ASW personnel are used to looking at—rather than as a digital output. They also point out, however, that highly accurate new recorders, such as the one being produced by Francis Associates, are equipped to provide rapid digitization of this data through optical scanning methods.

Since it is really the number of platforms for oceanography that controls the instrument market, and since the U.S., according to Navy oceanographers, has only about a 50-ship oceanographic fleet, the ability to develop instruments that can be widely used aboard ships of opportunity will do much to create an expanding market for builders.

- **Use of microelectronics**—This space technology is certain to become widespread in oceanographic instrumentation. Inherent reliability is one reason, but instrument users are also interested in the potential for circuit redundancy built into new devices intended for at least one year of unattended buoy duty. Water leakage problems with present instruments account for a very high percentage of failures, according to Navy scientists. All-solid-state, encapsulated devices are seen as a potential answer. Instruments for use with deep submersibles are also apt to get a heavy dose of microcircuits in order to improve buoyancy.

- **Standardization of specifications**—Prime mover here, particularly for survey instruments, will be the Navy's newly created Oceanographic Instrument Center at the Washington (D.C.) Navy Yard. The center, headed by Gilbert Jaffe, is headquarters for an expanding effort in test and evaluation of all classes of industry-produced ocean instruments.

Jaffe feels that the Center will play an important part in feeding back test data to manufacturers, a role which will be of major importance to many of the small firms which make up much of the instrument industry and which have limited resourses for R&D but good manufacturing talent.

The Center, now devoting much of its time to the expendable BT development, has already established standard procedures for testing and calibration of some simple instruments, such as deep-sea reversing thermometers and salinometers, and expects to move into actual hardware specs and test-procedures definition for more complex instruments such as airborne radiation thermometers.

"At the moment," Jaffe says, "each Navy agency defines its own specs, and there is no real agreement on what to buy or even where to go to get it. What we want to do in this first test and evaluation phase is first come up with some better specifications and tie all the agency requirements together." Jaffe says that the T&E reliability testing program to date "has found some pretty frightening things."

- **Integrated shipboard survey system**—Billed by the Navy as "the most advanced data-collection system in the world," the first fully integrated shipboard survey system is now being installed aboard the 2,600-ton, 280-ft.-long, AGS-26 (Silas Bent) in the Boston Navy Yard. The ship, which will begin sea trials in about 4 weeks and is expected to be declared operational by January, 1966, will set the tone for all future Navy ocean survey vessels. It is being built by BuShips, with the instrumentation system being assembled under NAVOCEANO contract. Texas Instruments, Inc., is the prime contractor for the instrumentation system.

Work on another ship of the same class, the AGS-27, is expected to begin soon. Using similar equipment, it is slated to be operational late next year.

The instrument system, according to TI, is the first of its kind to acquire and record data systematically in an immediately usable computer format. Measurements are made both under way and on-station. On-station depth-related measurements include: subsurface water temperature, sound velocity, salinity, and ambient light. Under way measurements include: magnetic field intensity, gravity field intensity, seismic measurements, surface water temperature, and two separate bathemetry measurements from a stabilized narrow-beam system and a conventional wide-beam system. Under way measurements can be made to speeds of 15 knots.

The system employs an AN/UYK-1 computer, records and displays data immediately in strip-chart and alphanumeric form, and records on magnetic tape in digital form for future reference and further processing.

Performance characteristics of the instrument system are summarized in the accompanying chart.

- **Free-falling devices**—Widespread use in bottom sampling is seen by many oceanographers for a whole series of free-falling instruments which promise greater accuracy and easier handling for surveyors. Development of free-falling corers has been pursued most vigorously by scientists at Woods Hole, and the units have achieved considerable success during recent cruises.

The device consists of a heavy, disposable coring unit, and a lightweight recoverable assembly of glass floats and plastic liner tube. The corer is dropped from the survey ship, rather than being slowly lowered, which removes the necessity for heavy lowering equipment and also removes errors in ship's position due to wind and current movement during the lowering.

The corer is sufficiently heavy so that it quickly reaches a velocity of 425 meters per sec., according to WHOI scientists, and is balanced to land nose-down on the bottom. This is done with enough force to drive a sediment sample into the recovery tube, which is then released and free-floats to the surface. Of 24 of these units dropped on a recent cruise, Woods Hole reports 23 were recovered. Accuracy of the drops is said to be excellent.

A number of coring devices are now beginning to appear on the market and other semi-expendable and "recallable" instruments are in development. They could lead to a new series of relatively inexpensive under way instruments. However, Woods Hole scientist Vine suggests that some of these new recoverable devices are not being designed with sufficient optimism or growth potential.

Vine sees the need for more reliable and more redundant recovery schemes which operate, for example, with bottom instruments which can be recalled to the surface on command. An increase in the degree of recall signal coding would be desirable, says Vine, and certainly necessary if the concept becomes more widespread.

- **Swallow floats**—Another set of instruments having potentially widespread application for both current measurement and as a short-range navigation aid are improved versions of the swallow float, buoyant devices which float free from attachment at pre-determined depth. When tracked acoustically they provide a measure of the current at that depth.

Efforts are now under way at WHOI and other places to increase both the signaling range and the lifetime of these floats. New floats, according to WHOI oceanographers, have a lifetime of a month and can be tracked by a surface ship with a towed hydrophone array from a distance of 16 km while the ship is making 10 knots, and from 25 km at lower speeds. WHOI reports that eventually it is hoped to use the sound channel to track truly long-range floats from shore installations, with preliminary studies indicating feasibility to ranges of 1,000-2,000 mi. Exploratory tests are now being discussed.

Use of improved swallow floats equipped with beacons for short-range navigation may generate a potential requirement for thousands of these units.

- **Other instruments**—"While there are now oceanographic instruments for virtually anything you want to measure," says NAVOCEANO's Gilbert Jaffe, "almost everything needs to be improved. There are a whole range of instruments which give us fits."

Among the problems, Jaffe lists:

- **Current sensors**—Mechanical and electro-mechanical devices need improving, both in the technique of making the instruments and using them. "There is a serious question of which component of current we are measuring. Also, the build-up and decay rates of mechanical devices are different on different instruments and this leads to conflicting data."
- **Sound-velocity devices**—A lot more must be learned, says Jaffe, about the effects of great depths and high pressure upon the pairs of crystal transducers which are conventionally used to make acoustic sound-velocity measurements.
- **Chemical sensors, including salinometers**—These need to be improved far beyond present water sample collection and later analysis methods to provide continuous direct measurements.

Miami University is developing a new Doppler-shift current meter, funded under an ONR contract, which scientists are optimistic about. The device will soon be tested in the Mediterranean. The system involves a single, narrow-beam transmit-and-receive unit for measuring energy reflected off water particles.

- **Marine biological sensors**—Here there is a drastic need to modernize techniques still in use after 50 years of service, according to many oceanographers. Improved and more reliable continuous-particle counters using either electronics to measure water conductivity or acoustic scattering techniques are sought.

Ocean scientists at A. D. Little Co. also see the need for a device to measure algae photosynthesis rate in the light zone, or the first 100 ft. of water, for detailed analysis of the rate at which organic matter is being produced.

Again, however, observers point out that if these and similar devices could be developed, "how many units could you sell?" The attitude is: "If the Navy doesn't have a requirement, forget it."

Several of the oceanographers interviewed felt that the newly created Environmental Sciences Service Administration within the Dept. of Commerce will create a demand for a badly neglected area of instrumentation concerned with the immediate air-sea interface area just a few meters above and below the surface—an area of water vapor, humidity, salt spray, temperature variations, which is, in general, complex and hard to define.

Also, scientists believe that the use of aircraft for oceanography has been spasmodic and largely ineffective, largely because of lack of good instrument development. Allyn Vine of WHOI suggests that if each aircraft manufacturer agreed to see through development of one instrument, aircraft use in general would be promoted to a far greater extent. Use of cameras, IR, radio altimeters, and monitoring receivers all would present interesting use, he feels.

- **Buoy-mounted instruments**—The major portion of ONR's FY '66 funding for instrumentation, which totals $940,000, is directed at its continuing project to develop a long-range telemetry buoy system able to operate unattended for one year and communicate over long distances.

Whether or not this buoy system ever is deployed in large numbers, the work going into study and development of the meteorological and oceanographic instruments to be deployed with the buoy are certain to contribute to improved instrument design and also to the development of digital data-handling systems aboard buoys.

Prime contractor for the buoy system, under development for ONR since 1960, is General Dynamics' Convair Div. Extensive evaluation of state-of-the-art techniques and selection of instruments is being carried out under subcontract to the Bissett-Berman Corp. ONR says the work is "riddled with small improvements in inductive-coupling of instruments to mooring lines for data transmission, anti-fouling and storage techniques, optimum battery types, FM data-retrieval and digital PCM conversion, transmission equipment, and packaging reductions on the order of 4:1 by redesign with solid-state devices."

The out-of-the-water meteorological instruments include wind speed and direction sensors, air-temperature, and barometric-pressure devices. The underwater sensors, studied by Bissett-Berman, include temperature, pressure, and salinity sensors.

The underseas instruments will each contain individual battery power packs, and will use the inductive-coupling technique to transmit FM/digital data up the mooring cable, rather than voltage data, to reduce chances of data loss through water leakage to the instruments.

Batteries being tested in the program include nickel cadmium types, zinc carbon, and cadmium mercuric oxide units. The firm looked into SNAP-15A nuclear units and found them impressive in reliability but too costly.

The firm has selected the platinum resistance thermometer and conductivity-sensing salinometer approaches for temperature and salinity measurements, and is currently evaluating several potential pressure transducers.

The contribution of the ONR project in the data-handling and communications field is described later in this article.

- **Sonar**—Use of sonar for oceanographic purposes is obviously one area where advanced technology has been applied primarily as a result of the overlap from sonar developments attached to the ASW and deep submersible project efforts.

Nevertheless, oceanographers say that one of the largest sonar markets in the world—that required by the fisheries—is left almost completely to European manufacturers.

For ocean engineering work, increased use of high-resolution side-looking sonar systems is indicated, primarily because of its ability to provide advantages in range vs. resolution that cannot be achieved individually with either longer-range, lower-resolution sonars or shorter-range, high-resolution optical systems.

Of the new optical instruments under development, unique new stereo camera systems appear to have considerable merit for photo-mosaic mapping of the ocean floor, but TV systems are still hampered by very severe bandwidth limitations imposed by data-carrying cables.

● **Data collection**—Impinging heavily on the requirement to improve ocean instruments is the equally pressing need to improve the quality of data received, the manner in which it is processed and handled, and the format in which it is usable and storable, as well as to selectively ferret out the most meaningful data from the most important areas of physical interest.

In general, the solution to all of these needs requires the development of more digital output sensors and an increase in use of digital processors and computers on board oceanographic vessels. This will enable the experimenter to quickly check his data, repeat the tests if necessary, transmit only salient data, and contribute data in standard computer format to storage facilities.

In addition, however, there are other efforts which are highly important to the overall problem of data collection. The two primary programs apt to cause the greatest expansion in oceanographic data collection include the ONR long-range telemetry buoy program and a rapidly expanding interest in use of satellite-monitored buoys. Both projects have the potential to make ocean data-gathering truly global and to redress the current data imbalance.

One of the major problems now is that too much data is returned from areas already well defined, but only scanty data is turned in regarding many areas of major interest to oceanographers.

Both of these programs really represent potential solutions to the problem of long-range communications from isolated, unattended stations—solutions that make oceanography economical, assuming of course that instruments are produced which make it worthwhile to transmit the data in the first place. The communications problem is a severe one for oceanographers, primarily because no special bands are set aside for this type of transmission and the HF bands are already crowded. Satellite monitoring at least holds out the possibility of removing this problem by moving transmission into the far less crowded UHF regions.

● **ONR program**—The ONR buoy is a discus-shaped hull, 40 ft. in diameter and 7½ ft. thick, with a 40-ft. mast which, together with the buoy platform, serves as the discone radio antenna.

The first of two buoys being built has been on-station off Florida since late 1964; however, tests so far have been of buoy seaworthiness and communications performance, such as antenna tilt parameters. The Digital Data Acquisition System (DDAS), which is the heart of the instrumentation complex, is not aboard. The second buoy, being built for Convair by the Rohr Corp., was delivered to the prime contractor in July, and is scheduled to go to the Pacific. Both buoys are expected to be fully operational by July, 1966, according to ONR's Feenan Jennings, head of the oceanography branch.

The DDAS, subcontracted to Beckman Instruments, is expected to be capable of providing 100 channels of PCM telemetry for ocean data and 10 channels of meteorological data using HF ionospheric transmission over minimum distances of 2,500 mi. ONR says the system can be made compatible with satellite relay.

The system is being tested for its long-haul capabilities by a uniquely outfitted shore station housed in a converted Greyhound bus. This allows the engineers to increase the link by simply driving rather than moving the buoy.

The DDAS will sample each channel once an hour and store the data in two magnetic-core memories—one a short-term unit which will be queried roughly four times daily from shore, and the other a long-term memory designed for one year's data storage. The DDAS can handle roughly 20 different commands and will be able to change sampling rates or instrument selection.

For data communications, ONR will use a newly developed narrow-band HF single-sideband radio transmitter with 100 watts average power. The radio, built by Cubic Corp., reportedly maintains frequency within 1 part in 10^7 per year. The radio has a 300-mc bandwidth in the megacycle region.

● **National Oceanographic Data Center**—NODC is the largest repository of stored oceanographic data in the world. If the scientists, instrument designers, and oceanographers can ever get together to bring more order to the facts they collect, they are certain to make life easier for NODC director Dr. W. C. Jacobs and his 120-man staff.

NODC is literally swamped with data, especially in BT readings, with backlogs equivalent to years of work for the Washington-based staff. NODC gets about 5,000 BT recordings a month; some of them are uncorrected slides, made from an imperfect instrument, which require considerable evaluation. Other BT data comes in printed form, on magnetic tapes, or as an autographic record. The problem of the BT data is probably indicative of several things which are wrong with the current way in which data is taken and preserved, and the NODC staff is now attempting to evolve some programs which will lend some order.

NODC is a unique organization in that its board of advisors and its budget come from 10 different government agencies. Yet its data and support also come from a lot of non-government institutes, and the lines of command in these areas are non-existent and require "some horse trading," as Jacobs puts it.

The primary requirement is to increase use of standard digital formats wherever possible to allow computer processing on a very large scale. NODC is now preparing some standard formats, but there is no central coordinating agency for this, and the attempt has not met with great enthusiasm or response from the geological and biological data seekers, for example. There is still some resistance to what some scientists consider to be throwing away data with digital techniques, and disagreement as to the number of bits of definition that is scientifically satisfying.

Jacobs adds that there is also a lot of data which is not handled properly in terms of its scientific content. Dept. of Defense data taken in classified programs may indeed contain unclassified portions which would avoid later duplication. Ice reconnaissance information is sometimes not processed properly in order to cull the scientifically useful data. *Tiros* satellite photos and tidal data may be in the same category.

Selective use of adaptive processing in oceanography could be highly advantageous; however, the ocean scientists are fighting the same battle that space scientists continue to fight—trying to overcome the reluctance to give up any bit of data. This reluctance can be especially persuasive in the ocean sciences because, as Jacobs puts it, "there is a diversity here which simply does not exist in any other physical science."

"We also need a better expression of scientific usefulness in instrument specifications," says Jacobs. "Companies have a tendency to influence specifications so as to show what the companies can do. We may not need this much data or performance, however, which contributes to redundancy."

Most important, perhaps, according to Jacobs, is "that the people who propose the oceanographic programs keep us in mind." ■

Satellites To Aid in Sea Studies

Two Apollo Extension System flights will carry oceanographic experiments to probe ice, waves, currents, geology and biology

by Hal Taylor

THE APPLICATION of Earth-orbiting satellites to world-wide oceanographic research promises to be the greatest state-of-the-art increase in surface platforms in the next five years.

At the same time, new oceanographic ships, advanced buoy systems and new aircraft systems are in the development stage as the U.S. oceanology effort begins to step up its pace with the sharp increase in Fiscal Year 1966 funding.

The most auspicious use of space-age technology will be new oceanographic experiments, which are currently part of NASA plans for the *Apollo Extension Systems (AES)*.

The experiments will be carried on at least two, and probably more, flights in the program, which is expected to have its first launch in 1968. The oceanology flights are scheduled for the second quarter of 1969 and the last quarter of 1970.

Preliminary plans call for measurements to be made in five major areas and more are expected to be added later. The areas are sea ice, waves and currents, coastal and marine geology, marine meteorology and oceanographic forecasting, and marine biology.

- **Scope**—Three separate oceanography experimental laboratories have been proposed. One will have a volume of 284.2 cu. ft. and a weight of 1,112 lbs., and will be part of the payload for the 1970 launch. Two others will be launched in the 1969 mission: one with a volume of 94.5 cu. ft. and a weight of 953 lbs.; the other will have a volume of 64.3 cu. ft. and a weight of 1,435 lbs.

Experiments in all five major research areas will be part of each of the three lab packages.

In the sea ice area, the space agency is interested in the measurement, identification and codification of spectral signatures for monitoring ice masses and iceburgs, and in mapping sea thickness to establish the utility of remote sensing from space for gathering data of functional use to the shipping industry. Techniques that could be used include radar imaging, microwave radiometry and pulsed VHF reflectivity.

In the waves and currents experiment, NASA wants to measure the spectral signatures of wind, wave and swell height and directional spectrum and observation of current meanderings to establish the feasibility of remote sensing from space to gather data for the oceanographic community.

Specific goals include the mapping of ocean currents, including TSUNAMIS, sea level changes and sea state conditions as an aid to the shipping and fishing industry, and to gather information for improving long-range weather forecasting.

Techniques to be used are optical observation of glitter and radar backscatter for wave measurements, and IR and microwave radiometry to observe currents by thermal gradients.

The coastal and marine geology experiment will try to use spectral signatures to monitor seasonal storms, induced changes in beach and coastal structures, and shallow water sedimentation to establish the feasibility of using remote sensors to gather such data.

NAVY'S auxiliary general oceanographic (AGOR) ships Bent, left, and Conrad. Nine such vessels are planned.

Techniques that could be used include a multispectral sensor system and high-resolution photography.

- **Air-sea interface**—Interest in marine meteorology and oceanographic forecasting calls for measurement of spectral signatures to determine the air-sea interaction and energy change by remote sensing. Techniques that are planned include radar back-scatter for determination of sea state and radiometric measurements of surface temperature and heat flux.

In marine biology, spectral signatures will be measured by remote sensing to monitor the migration of large marine animals and schooling fish and the factors influencing their distribution.

Equipment to be used includes an IR radiometer to thermally detect the mixing of surface and lower water by schools of fish and the multispectral photographic detection of bioluminescence and discoloration.

The space agency expects to fund the *AES* experimental program beginning with the FY'66 budget. Hardware development of some of the Earth-orbital experiments will be initiated later this year. While the work will be directed by various NASA field centers, the actual design and development of the experiments will be done by industry and the academic community, and, in some instances, by other Government agencies.

The *AES* program will move into the program definition phase in the near future—probably next month. Two or three firms will be selected in the first phase of PDP. One of the firms will be named later as the prime contractor for *AES*. Its primary responsibility will be integration of the spacecraft and its experimental payloads.

- **More time needed**—While NASA officials are enthusiastic about the application of satellite technology to oceanography, oceanographers who share this enthusiasm have some doubts about how well it can be carried out.

One oceanology scientist told MISSILES AND ROCKETS that NASA officials come to them and say " 'How would you like NASA to get data for you on oceanography research?' When we say, 'Great, go ahead and do it,' they usually reply, 'We can't do it yet.' "

While oceanographers have some doubts at this point, the achievements of the U.S. space program thus far—the photographing of the Moon and Mars, unmanned exploration of Earth and Venus, and manned eight-day orbital flights—indicate that NASA probably will be able to do what it says it can do—and on just about the launch dates indicated.

The earliest use of satellites in the oceanography area will be in the Navy/NASA project to build a satellite buoy-monitoring system. It has generated considerable enthusiasm and is viewed by many independent observers as definitely the way long-range global ocean surveillance of this type will go in the future.

NASA scientists believe the experiment has great potential. They plan an evolutionary multi-phase experiment of increasing complexity and involving an increasing number of buoys. The experiment will probably be initiated in early or mid-1967 using the *Nimbus B* satellite and the Interrogation Recording Location Systems (IRLS) being developed for the satellite by Radiation, Inc. (M/R, Mar. 8, p. 35).

No decision has yet been made concerning which agency will fund the buoy electronics or what type of power supply will be required. The power question is expected to be a key, with nuclear devices desirable but very expensive. NASA officials said the power requirements are dropping as "we study the system."

It is expected that the Navy's NOMAD buoys will probably be altered to take part in the experiment in addition to some other buoy types.

Use of shipboard-mounted equipment for navigating and getting sounding position fixes with the Navy's *Transit* satellite is already in service aboard research institute vessels, with accuracies to one mile possible. An expansion in the number of ships using these systems is planned.

- **Navigation satellite system**—The space agency is also working on studies of the feasibility of a world-wide navigation satellite system. Joining in the effort are the Department of Commerce, the Department of Interior, the U.S. Navy, the Maritime Commission and the Weather Bureau.

An ad hoc committee, with representatives from each of the interested agencies, has been meeting for about a year to clear up the details of the engineering, management and funding of such a system.

The most recent development is the decision to fly a navigation experiment on one of NASA's future *Application Technology Satellites (ATS)*. The first launch of an *ATS* is now scheduled for 1966. It is believed that the first navigation experiment will be flown early in 1967.

- **Watching the weather**—NASA, the Weather Bureau and other government agencies are hoping to combine satellites, buoys and balloons into a system that will provide long-range worldwide weather forecasts of up to two weeks, compared to the present 48-hr. limit of accurate forecasting.

The project—not yet approved or funded—grew out of a NASA/Weather Bureau study that used radio waves as a sensing device. The radio waves made a profile of the weather layers from a balloon that reached an altitude of 100,000 ft.

The data enabled scientists to visualize the structure of the Earth's atmosphere more accurately than was possible previously. The findings were later verified by a radio weather recorder carried aloft in a balloon.

Among the data collected were the water vapor content and the altitude and amounts of carbon dioxide and ozone in the atmosphere, wind shifts, and pressure reading at the surface and tops of clouds. This is the data needed to make forecasts.

The two agencies now want to extend this to a world-wide system in which automatic buoys would be placed in areas of the world in which weather data are not now collected. The buoys would be queried by satellites—using equipment similar to the IRLS system to be flown on *Nimbus B*. At the same time, balloons would be placed in various areas and their data transmitted to the satellites or ground stations.

The Weather Bureau estimates that 450 buoys would be needed for worldwide coverage. In addition, new, highly sophisticated weather satellites will have to be developed.

- **New oceanographic ships**—Funding of new oceanographic ships by the U.S. Navy has increased slightly in FY '66 to $11 million, compared to the $9-million program in the last fiscal year.

Two new ships will be added to the Navy fleet, bringing it to a total of nine AGOR ships. The two advanced-design vessels will be assigned to private institutions for research in support of Navy requirements.

The new ships will have a displacement of 1,750 tons. Previous experience with the AGORs is being used to develop a new design that will have such special features as engine room automation to reduce operating costs, an internal well, a capability for handling and tending manned deep research vehicles up to 20 tons, equipment to tow and tend manned deep-sea buoy stations and manned undersea vehicles and portable van storage.

Two more AGOR ships will be funded in Fiscal 1967, according to Navy officials.

The Bureau of Commercial Fisheries (Commerce Dept.) plans to spend about $700,000 to complete construction and equipping of a new ship for exploratory fishing investigations and related oceanographic studies in the Gulf of Mexico, the Caribbean Sea and the tropical Atlantic. The 800-ton ship will be completed in FY '66 (called the Oregon), and further expand the bureau's capabilities in the western Atlantic.

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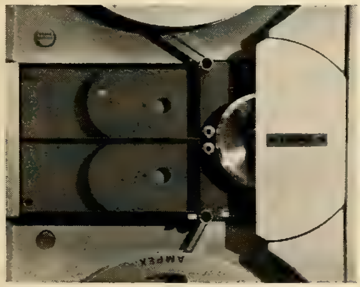

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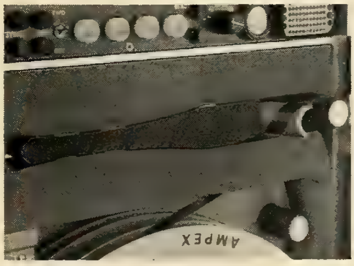

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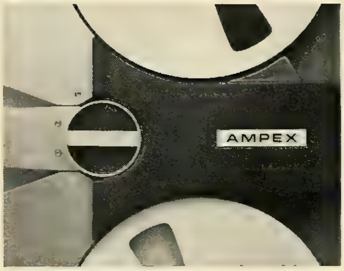

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The bureau is also funding the conversion of a 500-ton vessel, the George B. Kelez. It will be used for oceanography and fishery biology in the northern Pacific.

The National Science Foundation is supporting the construction of one ship and a design study for another. The new ship is a 100-ft. wooden trawler that will cost $700,000 and will be used for studies of coastal and marine biology in Antarctica.

NSF is also studying a floating research facility to be imbedded in the Arctic sea ice. It is expected that the natural drift of the ice will carry the facility in circular courses that will reach most of the areas of interest to U.S. scientists.

Since FY '60, $158 million has been budgeted for oceanographic ship construction. It increased the total number of U.S. ships by 42 and brought the complete U.S. fleet to 95 vessels. According to oceanographic experts, this compares favorably with all the other 51 nations of the world engaged in exploration of the oceans.

● **Buoys**—There is a continuous requirement in oceanographic research for buoys that can be anchored in the deep sea to collect data over long periods of time.

Because of the scarcity of funds, research institutions have been primarily interested in the research work rather than in development of such a specialized buoy.

The Office of Naval Research in 1959 initiated one of the largest state-of-the-art increases in buoy technology when it decided to sponsor the development of a large general-purpose telemetering buoy.

The first three years of the program were devoted to determining:

—The optimum radio frequencies for reliable data transmission over long distances up to 2,500 mi.;

—The best antenna configuration for the radio frequencies to be used and the effect of tilt and motion on the radiation pattern of these antennas;

—The drag characteristics of a wide variety of buoy shapes and sizes, and the motion characteristics of these sizes;

—The optimum electrical power source to meet the requirements of the data handling equipment.

● **What resulted**—The final results of the studies produced a buoy having the following general characteristics:

—The buoy hull is discus shaped—40 ft. in dia. and 7½ ft. thick, with the bottom 4 ft. of the hull tapered inward at an angle of about 60 degrees. Mounted on the hull is a 40-ft. mast that acts as a snorkel for the engine generator and as part of the discone radio antenna.

—Electrical power is supplied by two 4-cycle engine/generators used alternately for charging a nickel-cadmium battery bank. Propane is used for fuel in the engine and the generator is a 1kw, 28v dc design. It is to provide a continuous output of 200 w.

—The radio transmitter for telemetering will operate on command from a shore station. It is planned that three to four frequencies between 3 and 30 mc will be available, thus providing sufficient flexibility.

—The data system will handle 100 scientific channels. These will be sampled once an hour and the data stored in two memories: the short-term memory will be used for telemetering of data to shore and will report all the data collected during the past 24 hrs. each time it is queried—every six hours; the long-term memory will store all the data collected during one year of operation.

—The data will be transmitted in binary bits as a pulse-code-modulated signal on a frequency shift keyed subcarrier (FSK). The radio equipment will be single sideband with 100w average power.

The program calls for two complete prototype buoys and one shore comman station. Construction of one buoy has been completed, and construction of the second hull is under way by General Dynamics/Convair—the prime contractor in the program—in California.

The first buoy is anchored in the Gulf Stream just off the coast of Florida near Miami. The second buoy will be placed in the Pacific Ocean and will be used to monitor the different conditions in that ocean, such as longer-period waves and oscillatory currents.

The first prototype—called Bravo—has provided the longest history of current velocity records yet obtained in the Gulf Stream or any other major current system in the world.

● **Early success**—The success of the first buoy has prompted ONR to move toward the operational phase. They have asked six separate groups to prepare an oceanographic research program which will use the buoys. They expect to select the best program by the end of the year.

As soon as the research program is chosen, the decision to go to hardware development of the buoy will be made.

The number of buoys built will depend on the size and requirements of the selected research program.

The new buoy could be used by quite a few other groups if its operation continues as successful as it has thus far. According to one ONR official, the Coast and Geodetic Survey may adapt the system to its needs.

The Coast and Geodetic Survey has already developed for its use the deep-sea stable submerged platform. It consists of a sub-surface buoy held at a depth of about 30 meters by a system of three cables with vertical, horizontal and torsional movements reduced to a minimum.

The instrument package is retrievable on command and contains a magnetometer and sensors for measuring oceanographic data.

● **Aircraft systems**—The Navy's Oceanographic Office, a pioneer in the use of airplanes for oceanography, recently assumed technical control of the Navy's first Oceanographic Air Survey Unit.

Consisting of five multi-engine aircraft—four Super Constellations (NC-121's) and a Skymaster (CO-000)—the unit was commissioned early in July 1965 at Patuxent River Naval Air Station, Md., where the aircraft will be based.

Operational control is under Rear Adm. James R. Lee, USN, Commander, Fleet Air Patuxent. The new commanding officer of the unit is Cdr. H. R. Hutchison, USN.

Four of these aircraft are equipped for airborne oceanographic work and are tailored for important oceanographic projects in magnetic charting, ice research and data collection for antisubmarine warfare support. A fifth plane will be used for training purposes.

"Although the concept of using airplanes for our work is not new," said Rear Adm. Denys W. Knoll, commander of the U.S. Naval Oceanographic Office and Oceanographer of the Navy, "we have never before had a squadron designated specifically for this purpose."

In 1953, planes began flying in support of Project Magnet, the Oceanographic Office code name for a worldwide magnetic charting program. The data is also used for advanced navigational systems, space programs and other scientific programs of the U.S. Two aircraft, flying from bases in Alaska, Norway and Greenland, have since flown a combined total of one-half million survey miles.

The Antisubmarine Warfare Environmental Prediction System (ASWEPS), now under development, is a third Oceanographic Office project using an aircraft. A Super Constellation equipped with an airborne radiation thermometer flies over the sea, making continuous measurements of sea surface temperature. This data is used in determining thermal patterns, which affect both submarine and ASW operations.

Scientists on this project are also testing new methods for measuring waves. They are attempting to use aircraft to predict wave characteristics over wide ocean areas. ■

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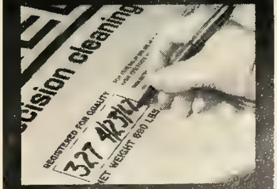

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Industry Struggles to Meet Demand

Aerospace firms, logical builders of manned and remotely controlled vehicles, are stepping up spending to solve problems

by Charles D. LaFond

"IF ALL THE MANNED deep-diving submersibles now planned by those involved in the field of oceanology were available for operational use today, a shortage would still exist. And the need is steadily increasing." This was the consensus expressed by five ocean science experts at a press conference during a major meeting in Washington last June.

Their argument was unequivocal: If man is to work with or study the ocean environment, then he must at times be prepared and capable of directly performing functions or observing or collecting data. His acuity, perception, flexibility and adaptability make him a necessary tool. These recognized attributes also will serve to provide him with the desire to be there.

At the same time, the need for unmanned remotely controlled vehicles and instrumented platforms is growing at an even faster rate. In fact, oceanologists most vocal concerning the general requirement for more and better manned vehicles are equally quick to emphasize that the real issue is to select the best system approach for each mission.

• **Platform trends**—The impetus of increased Federal funding for a national oceanographic program and the Deep Submergence Systems Project have forced industry to invest to strengthen its marketing capability. Thus, more funds have become available.

Coincidentally, the U.S. aerospace industry had expanded to a level exceeding the funding necessary to support it at that level, and hence was looking for new avenues of exploitation.

The manned and remotely controlled submersible was a natural for this industry, according to Dr. A. B. Rechnitzer, assistant director of the oceanology effort at Autonetics Div. of North American Aviation, Inc., because of its unparalleled experience in R&D and fabrication, test, instrumenting and data-handling with a system approach. All the skills were available—the metal benders, the microminiaturizers, the metallurgists, the instrument builders and the communicators, navigators and acoustics engineers. In general, only the oceanographers were lacking, and these were rapidly proselytized from the universities and ocean-science institutions.

A new industry was created within a new industry. The results are becoming evident. Facilities are being built to support the development and testing of whole families of new vehicles. Half-built submersibles throughout the nation are awaiting solutions to problems not anticipated by their designers. Some radically different and highly advanced vehicles have defied immersion and proudly kept their seams in place.

Somehow, out of this "instant industry" have come the first vessels of a much-needed fleet of underwater research and work craft. Testing and initial operation are further defining design weakness and instrument needs.

• **Problem areas**—Two difficulties associated with powered submersibles—communication with the mother surface ship and navigation—are paramount, particularly with deep diving vehicles with extended range.

In Navy-supported operations where acoustic beacons can be planted and where surface ships carry extensive navigational systems, the problem is minimal. But, for the normal oceanographic venture, such equipment is expensive and often unobtainable.

Surface craft find accurate position determination impossible. For the submersible, it is even worse. If the underwater craft exceeds a slant range of 15,000 ft. from the surface ship, it begins to encounter steadily worsening communications. Often temperature change in water layers above the craft creates interruptions. Without good communications, the task of updating his position becomes impossible.

Also, determination of true submersible velocity with respect to the ocean floor is not always reliable. If the submersible is cruising at over 150 ft. from the sea bottom, the true speed indicator is almost useless.

The problem raised by inability to navigate and determine position is not that of becoming lost (since operating speeds are low and duration is normally short) but that collected data cannot later be correlated with a known position or course relative to the sea bottom.

Continuous communications are so necessary to the Sealab II experiment (wherein men are living and working in a stationary pressurized shelter at 205 ft. for 30 days) that both primary and secondary links will be by hardline—to a Benthic laboratory and to a surface ship, respectively. The former is a remotely located instrumentation and communication terminal linking Sealab to the shore. To assure its continuous operation, said Dr. Victor C. Anderson of Scripps' Marine Physical Laboratory, the submerged terminal will be so provided with lights, video cameras and manipulators that defective circuit boards and other units can be replaced by an operator at the shore station.

Other areas in which early improvements are needed include:

—*Sonars.* Better resolution for scanning-type, faster search rate for side-looking type. (One overall solution to the sonar problem, suggested Dr. Carl Lowenstein of Scripps MPL, would be development of a frequency multiplex acoustic system or possibly an FM sonar with the resolution of a side-looking sonar.)

—*Power.* Long-duration missions are still power-limited. Batteries are in general use because of their safety advantages, but fuel cells and nuclear reactors (small) offer the best solution for the near future (3-5 years).

DSSP VEHICLES AND PLATFORMS

With a rapid increase in the number of submerged platforms coming into use, carrying not only human cargo but valuable instrumentation, probability of failure or loss grows. The Navy's Deep Submergence Systems Project vehicles will provide a means for deep-water search, rescue and salvage. Out of the project certainly will come a new submersible family and new operational techniques that are badly needed. In general, the military need differs little

ALUMINAUT, all-aluminum research submarine designed to dive to 15,000 ft., heads for sea during initial trials. The boat, built by the Electric Boat Div. of General Dynamics for Reynolds International, Inc. so far has passed the 2,700-ft. mark.

from the non-military.

The Navy's Special Projects Office has overall responsibility for the program; the Nortronics Division of Northrop Corp. is serving as the industrial vehicle-program coordinator. Parallelling the vehicular development is the man-in-the-sea portion of the project wherein, through extended use of submerged habitable shelters, man's usefulness at great depths may be prolonged.

● **Vehicular effort**—Essentially three vehicle types will be required in the project—one for rescue and two for search at different depths. Design configuration will be similar, in that all probably will use spherical-pressure hulls connected by smaller-diameter cylindrical sections.

The rescue vehicle will employ four spheres. One forward will be for the control section and one aft of the same size for housing survivors. A smaller passage sphere connects the larger hulls together and rides atop a second small transfer sphere. The latter is to be mated to the distressed vehicle. HY140 steel will be used.

Measuring 42-44 ft. in overall length by 8 ft. in diameter (permitting air transport in a C-141 aircraft), the 25-ton craft will be capable of operation to depths of about 3,500 ft. It will cruise at 3 knots for up to 12 hours, and will be capable of 5 knots maximum. It will carry a crew of three (including one medic) and carry 12 survivors.

A single screw in a controllable ring tail will provide thrust; hovering control in three axes will be provided by a pair of 18-in. thrustor ducts at the bow and stern. Roll control will be by mercury trim.

At present, Nortronics is working under a $500,000, one-year contract that began July 6, 1965. It is expected that the firm will continue in its present capacity at least through the development of the initial search and rescue vehicles. The contract includes a hardware-exclusion clause.

Arthur E. Krapf, Nortronics DSSP manager, says initial design studies are nearly complete and requests for quotations (RFQ's) will go out this year to industry for the rescue vehicle. The winner will prepare detailed designs beginning in July, 1966, and start construction of a prototype which should be in the water by July, 1967. A second tactical vehicle probably will be called for under an additional contract. The first vehicle should be operational by July, 1968. At that time, said Krapf, a third contract for five more tactical vehicles will be awarded.

The search vehicles, capable of operating to 6,000 ft., will be similar in overall design to the rescue vehicles but will be much more heavily instrumented and will carry external manipulators. Under present plans, two will be built. The first contract will be awarded in May, 1968, and be "wet" by March, 1969. Studies, principally in the area of sensor research, are now in progress for the search vehicles.

The third vehicle type will be for 20,000-ft. depth search. Similar to its predecessor, it will be provided with a vastly stronger-pressure hull, more electrical power and, it is hoped, better communications and navigational subsystems. Operating time at depth probably will be extended.

Initially, 40 Navy submarines will be equipped to carry the rescue vehicles. These will, after air transport to the mother sub, carry the vehicle to a disaster scene and then, operating either on the surface or submerged, await transfer of survivors.

The rescue vehicle will be able to mate with a damaged submarine within several minutes after reaching the hulk and to attach at any deck angle up to 45 degrees. Simple seat-pack ballast will be carried down and replaced by the survivors.

● **Sealab I and II**—During the summer of 1964, four men were housed in Sealab I at a depth of 200 ft. off the Bermuda coast for a period of 11 days. In the DSSP effort, the goal was to

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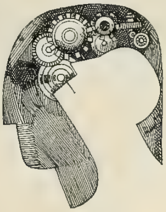

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With the success of that experiment, Sealab II was developed. Astronaut Scott Carpenter and nine other team members on Aug. 27 began a 45-day test aboard the craft 205 ft. under water off San Diego, Calif. Carpenter was to stay aboard for 30 days, the others for overlapping 15-day periods. (French oceanographer Jacques Cousteau has already performed a similar 30-day study at 65 ft. in the Red Sea last summer and repeated the experiment at 300 ft. in the Mediterranean.)

Ultimate goal in the present program is to learn to adapt man to useful work at depths from 600-1,000 ft.

- **Bathyscaphes**—Trieste II, the famed deep-diving bathyscaphe built by the brothers Piccard in France, will soon undergo modification at the Mare Island (Calif.) Naval Shipyard and then be employed to test instruments and equipment for use in the DSSP.

Sperry Rand's Sperry Gyroscope Division also is working navigational and control subsystems for the vehicle, including a Doppler sonar to measure true motion with respect to the sea floor.

Another bathyscaphe now being considered for construction at Mare Island may eventually assist in the DSSP.

ADVANCED VEHICLES

Deep submersibles have been built in backyards as well as in giant industry installations, but in general the trends are being set by industry. Many firms either have or contemplate a series or family of vehicles. Some of today's and tomorrow's leaders are shown below with the highlights of their submersibles. (Refer to the Chart of Advanced U.S. Submersibles.)

- **Electric Boat**—After the successful operation of its two earlier submersibles, Star I and Star II, General Dynamics, Electric Boat Division is now continuing the series with a Star IIA and Star III. Both will be available when operational for lease and for use in the firm's own research efforts.

Star IIA will be almost a duplication of Star II except that it will have a 1,200-ft. diving capability through the use of HY80 steel pressure-hull construction. Test and checkout time for the newer vehicle is expected to be minimal and the craft is due to be ready for sea trials by December. Construction was ordered early in August.

Star III, with a 2,000-ft. capability, is well along in construction. Looking very much like a shark, the advanced vehicle will employ a main propulsion motor in the stern and bow and vertical thrustors for hovering and maneuverability. It will cruise at one knot and have a maximum speed of six knots. The 10-ton craft will carry all necessary navigation, communication and sensor equipment and will be provided with a manipulator.

The pressure hull, of HY100 steel (½-in.) measures 5.5 ft. in diameter.

In January, 1965, Electric Boat completed a feasibility/conceptual design study for the Biological Laboratory of the Bureau of Commercial Fisheries in Honolulu for a large, long-duration research submersible. Its principal need is for the systematic study of tuna and other pelagic fishes throughout the entire central Pacific Ocean.

Thus, the highly instrumented laboratory would have to be self-sufficient and capable of dives to 1,000 ft. for periods of two to six weeks. A total cruise capability of 30 to 90 days is required.

The EB design calls for use of HY80 steel, with hemispherical head and cylindrical section hull construction. Power would have to be nuclear, providing 3,240 total shaft horsepower. Collapse depth of the vehicle would be 1,500 ft.

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Advanced Manned United States Submersibles

Name	Diving Depth (ft.)	Dive Duration (hrs) /Speed (knots)	Crew	Payload	Size (ft.)	Weight w/o Payload	Designer/ Builder	Operator	Intended use	Status
(none)	1,000	6 weeks/ 20 (30-90 day cruising, 25,000-mi. range)	24	7 scientists	163.5 lg. 23 dia.	?	Elec. Boat, GD/none	Bureau of Comm. Fisheries Bio. Lab, Honolulu	Exploration and development of fishery resources in central Pacific Ocean & support of oceanology research	Feasibility/conceptual design study completed Jan., 1965. (Vehicle will require 4½ yrs. to build.)
ALUMINAUT	15,000	32/3	3	3-4 scientists	51 lg. 8 beam 14 h.	73 tons	Reynolds Internat'l/ Elec. Boat	Reynolds Internat'l	General oceanographic research	Completed 2,700-ft. dive and 30-hr. endurance run. Accepted from builder; tests dives continuing. Full depth expected by early '66.
ALVIN I	6,000	8/2	2	1,200 lbs.	22 lg. 8 beam 13 h.	13 tons	Office of Naval Research/Litton	Woods Hole Oceanographic Institution	General oceanographic research	Operational: Two additional vehicles planned.
BEAVER	1,000	6+/3	2	—	18 lg. 10 beam 9 h.	10 tons	Autonetics Div., NAA	—	General work vehicle	Conceptual design only. No construction planned at this time.
DEEP QUEST	6,000	12/4.5 24/2	2	2 scientists	40 lg. 19 beam 13 h.	50 tons	Lockheed	Lockheed Missiles & Space Co.	General oceanographic research, commercial use	Scheduled to be operational by late '66.
DEEP STAR 2,000	2,000	6/3 12/1	1	2 scientists	18 lg. 11.5 beam 7 h.	9 tons	Westinghouse /Cousteau	Westinghouse	General oceanographic research, commercial use	Scheduled to be operational by mid '68.
DEEP STAR 4,000	4,000	"	"	"	"	"	"	"	"	Scheduled to be operational by late '66.
DEEP STAR 12,000	12,000	"	"	"	"	"	"	"	"	Scheduled to be operational by late '68.
DEEP STAR 20,000	20,000	"	"	"	"	10 tons	Westinghouse	—	"	Titanium hull in development; full construction not expected before 1970-72 period.
MORAY	6,000	3.6/6	2	200 lbs.	33 lg. 5.3 beam 5.3 h.	10 tons	NOTS, China Lake	NOTS; China Lake	Ocean acoustic research (no viewports)	Ring-stiffened fiber glass hull—positive-buoyancy.
STAR II (Asherah)	600	10/1 2/4	2	250 lbs.	17.0 lg. 7.7 beam 7.6 h.	8,500 lbs.	Elec. Boat, GD	Elec. Boat & Univ. of Pennsylvania	General oceanographic research	Operational (owned by Univ. of Penn. and leased by Elec. Boat).
STAR IIA	1,200	10/1 2/4	2	250 lbs.	17.0 lg. 7.7 beam 7.6 h.	8,500 lbs.	Elec. Boat, GD	Elec. Boat	General oceanographic research	Initiated Aug., 1965. Scheduled for sea trials Dec., 1965—s/a Star II except hull strength.
STAR III	2,000	10/1 2/4	2	1,000 lbs.	24.5 lg. 6 beam 8 h.	10 tons	Elec. Boat, GD	Elec. Boat	General oceanographic research	Under construction; sea trials in 1966.
STAR IV	6,000	—	—	—	—	—	Elec. Boat, GD	—	General oceanographic research	Conceptual design only.
TDP-15 (DSSP Rescue)	3,500	12/3-5	3	12 survivors	42-44 lg. 8 dia.	25 tons	Navy-Nortronics/ none	Navy	Rescue of personnel from submarines	Preliminary design complete. RFQ's for detailed design and prototype in late 1965.
TDP-16 (DSSP Search)	6,000	12/3-5	3-4	—	42-44 lg. 8 dia.	26-27 tons	Navy/none	Navy	Search and recovery of small objects	Sensor and material research. RFQ's for detailed design and two vehicles—1968.
? (DSSP Search)	20,000	10/4-5	3-4	—	30 lg. 10 dia.	25 tons	Navy/none	Navy	Search and recovery of small objects	Prototype development not before 1970.
TRIESTE II	20,000 (Terni hull) 36,000 (Krupp hull)	5/2	3	10 tons	67 lg. 15 beam 18 h.	50 tons	Piccard, modified by Navy	Navy	General oceanographic research	Presently equipped with Terni hull.
U.S. BATHYSCAPHE (unofficially Trieste III)	probably 36,000	—	3	—	—	—	U.S. Navy/ Mare Island Shipyard	Navy	General oceanographic research	Design not yet firm. Due for completion late 1966.

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- **Reynolds International**—The Aluminaut is no stranger to any informed citizen. It certainly is one of the world's most advanced submersibles. With its all-aluminum hull, multi-motor propulsion and relatively large size, it also represents a marked change in design from all other craft.

Long-duration operation (over 30 hrs.), 15,000-ft. operating depth, and a heavy payload (6,000 lbs.) were the requirements around which the craft was designed. The Electric Boat Div. of General Dynamics was prime contractor.

With last month's record 30-hr.-duration and 2,700-ft. dive off the coast of Florida near the Bahamas, the boat was officially accepted from EB by Reynolds. Test dives will be continued—barring any serious problem—until the maximum operating depth is reached. (Collapse depth is about 23,000 ft.)

Instrumentation on the craft is extensive, including video cameras and lights, manipulators, and side-looking sonar. A single pilot can control the vehicle from midship and scientists working at the forward plexiglass viewports can take over the controls with a remote system.

A massive manipulator system with a large family of replaceable tools is being developed for the vehicle by GE.

- **Westinghouse**—By leasing the Cousteau SP-300 Diving Saucer over two years ago, the Westinghouse Undersea Division rapidly jumped into the submersible field. It in turn leases

ASTRONAUT/AQUANAUT Scott Carpenter stands atop Sealab II on Aug. 27 and gives signal for craft to be lowered to bottom of Pacific.

the vehicle and will serve as agent for future sales.

At the same time (mid-'62), the firm commissioned the Cousteau/OFSR organization to build an advanced 4,000-ft.-depth submersible using Westinghouse designs. Another craft was ordered for the 12,000-ft. region.

There seems to be some doubt as to which vehicle was desired first; nevertheless, the result of the effort has been the development of a family all using the same float designed for 20,000-ft.

The 4,000-ft. vehicle has encountered delays but is expected to reach the San Diego area for testing sometime this fall. The Navy Electronics Lab there is expected to lease the vehicle as soon as it can be Navy-certified.

Because of difficulty in developing the 12,000-ft. hull, the firm settled for another vehicle rated at 2,000 ft. to expedite early availability. Work on the deeper-diving vehicle is continuing and it should be ready for testing in 1967.

The 20,000-ft. craft represents a much greater challenge. A titanium-hull development project is being pressed by Westinghouse. If and when such a hull becomes available, the Underseas Div. probably will complete fabrication of the vehicle.

- **Lockheed**—Deep Quest, Lockheed Missiles & Space Co.'s new submersible now under construction, will employ dual intersecting spheres for its pressure hull. The opening at the intersection will serve as a 3-ft.-dia. passage between spheres. The hull is being fabricated by Sun Shipbuilding and Drydock Co. and will be man-rated to 6,000 ft. before installation in the Lockheed-built outer hull or float. The latter will employ aluminum construction, the hull maraging steel.

According to the developers, dock trials will begin next summer and the vehicle should be ready for lease by January, 1967.

The system design will permit an installed equipment payload of 3,400 lbs. and an additional capability for 7,000 lbs. A fully integrated maneuvering system is being developed to provide five degrees of freedom. Manipulators will be available.

- **CEL/Port Hueneme**—The U.S. Naval Civil Engineering Laboratory (CEL) at Port Hueneme, Calif., is employing a series of Submersible Test Units off the Pacific coast. In depths varying from 2,340 to 6,700 ft., the unmanned STU's have been emplaced for use in obtaining a multitude of near-bottom measurements and for studying sea-water corrosion effects and biomarine effects on metal and non-metal samples.

In time, units will be lowered to depths of 12,000 to 18,000 ft. for periods of up to 48 months. ■

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Present-day deep-running submarines have brought an increased need for an effective method of escape in critical situations. Long concerned with this problem, the survival system branch of the U.S. Naval Applied Science Laboratory joined Hercules engineers in developing an escape capsule capable of withstanding severe pressures during ascent.

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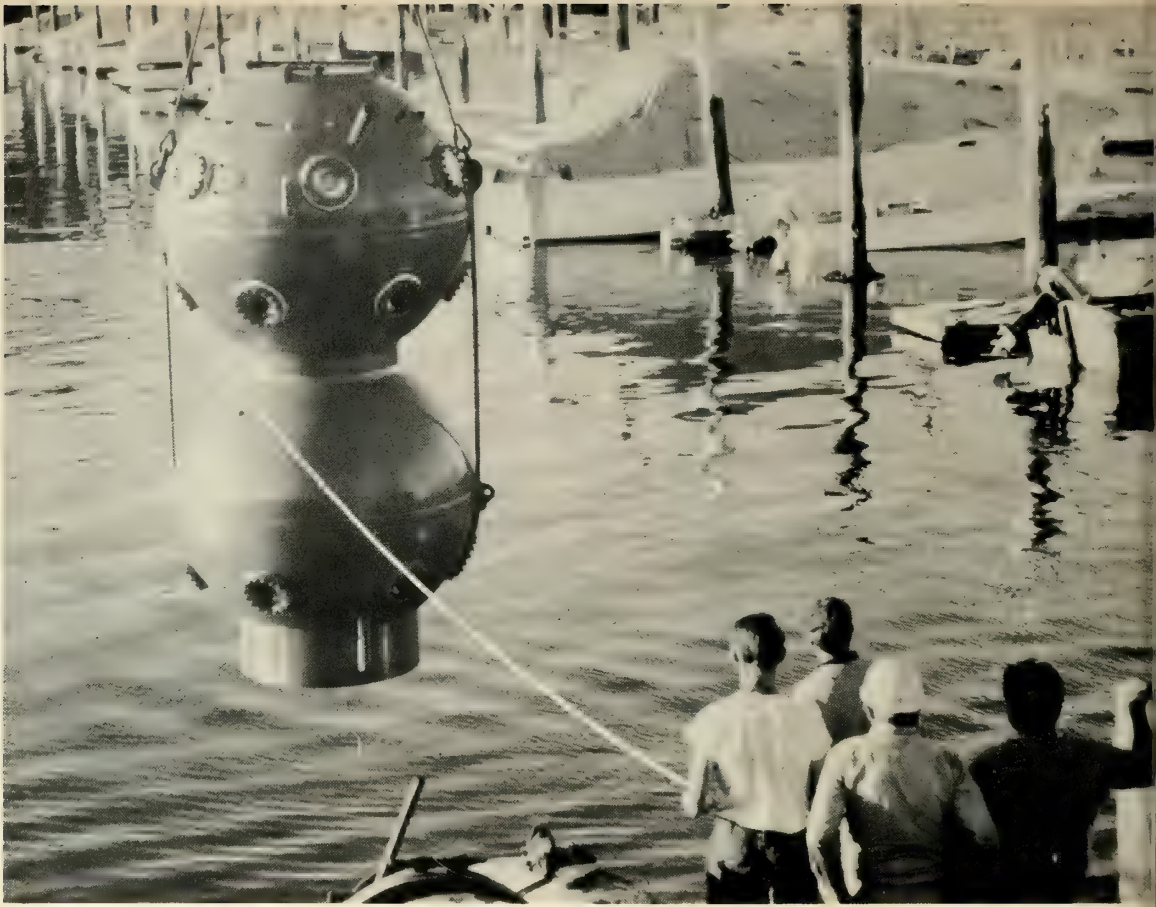


SUBMERSIBLE, both chambers of which can be pressurized, is readie by Ocean Systems, Inc., to transport divers to working depths

oceanology

LIFE SUPPORT

Depth Problems Yielding to Research

Findings of Deep Submergence Systems Review Group, need for rescue systems stimulate man's desire to go deeper

by Heather M. David

THE SCIENCE of man-in-the-sea is on the brink of advances that will open 30% more of the surface of the Earth—areas until now barely explored.

The extension of man's experience below the sea has been mostly a process of chipping away at the records—individual divers going deeper and deeper each venture. The process has been accelerated, however, with the impetus given the field since the Thresher disaster in April, 1963, and the recommendations of the Deep Submergence Systems Review Group (DSSRG).

Within the next few months, these new approaches will be investigated:

—The use of neon as an atmospheric diluent to replace helium. Theoretically, neon offers a happy combination of eliminating the danger of narcosis at extreme depths associated with helium, which has just been reported by the British, and removing the communications and thermal transfer complications. It would appear that it will cause no decompression problems.

—Equipment design advances to decrease breathing resistance, a pronounced problem at extremely high pressures.

—Development of pressurized vessels in which divers can be returned t surface craft during inclement weathe or at the onset of darkness. They woul remain at the pressure at which the were working for return to depth th next day, eliminating many hours o decompression otherwise required fo each dive.

—Perfection of decompression o "diving" tables to ensure complet safety for all divers as lower limits ar extended.

• **Records**—The present depth capability of the U.S. Navy diver is re orted as 380 ft. for 30 min., using n oxygen/helium gas mixture. Few ivers have exceeded this limit by very any feet, or for significant time eriods. The Navy itself has made a umber of simulations around 500 ft. or half-hour periods. Divcon Assoiates, a commercial firm, made an acual dive in September, 1964, to 525 ft. or 25 min. to repair an oil well head.

Hannes Keller, a Swiss mathemaician, has made brief dives of about 0 min. to around 700 ft., and a record ive in which he descended in a presure chamber to 1,000 ft., then swam ut briefly.

A record venture for duration at epth was the dive of 48 hours to 432 t. made by Robert Stenuit and Jon indbergh, in July, 1964, both now with cean Systems, Inc. The same company as now completed a simulated dive of 8 hrs. at 650 ft., also a significant chievement.

The two Sealab ventures have been ore experiments in the problems of ong-duration stays at medium depths. ealab I, an experiment by the Navy n July, 1964, was performed by four en for 10 days at 192 ft. Sealab II, ow under way, may last as long as 45 ays, with two teams of 10 men living t a depth of 205 ft. for periods of 15 ays each and Astronaut Lt. Cmdr. M. Scott Carpenter spending 30 days in the ocean laboratory.

These have been the record-setters, however. The goal of the DSSRG—to extend the day-to-day capability to 600 ft.—has not been attained.

Physiological Problems

Knowledge of the dangers of the deep sea is ancient. Yet, as Capt. George Bond, one of the foremost U.S. experts on the field and head of the Navy's effort for the DSSRG said recently: "Although it is now possible to place and maintain man on the continental shelves of the world, our early efforts are clumsy, relatively hazardous, and severely constrained by available knowledge of some basic physiological processes and lack of special equipment with which to do the job."

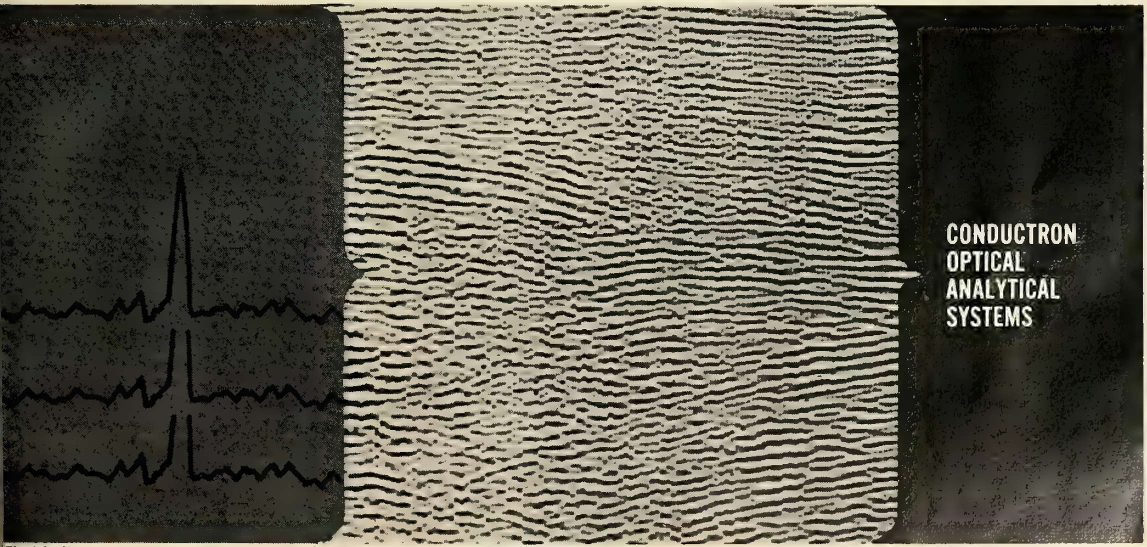
● **Oxygen toxicity**—The search for the basic cause of the syndrome of oxygen toxicity has been under way for 90 years, Bond pointed out, yet the mechanism is not yet known. Could the cause and cure of oxygen toxicity be found, it would expand man's underwater capabilities "by at least a full order of magnitude," he estimated.

The safe-depth limit for breathing oxygen, according to Dr. Robert D. Workman (Capt., USN MC), chief medical officer for the Navy's Experimental Diving Unit (EDU), is two atmospheres (33 ft.) for one-half hour. Beyond this limit, nausea, vertigo, muscle twitching, visual and auditory disturbances, unconsciousness and convulsions may occur.

Careful attention must be given to keeping the oxygen percentage of the diver's gas mixture regulated in order not to exceed this amount. At 380 ft., which is 12 atmospheres, for instance, the oxygen content must not exceed 17% of the mixture. This limit also is time-dependable; for a 4-hr. exposure, only 1.2 atmospheres is permissible.

Since oxygen breathing would be a boon in reducing decompression time, there is keen interest in enhancing its use, perhaps pharmacologically. The Office of Naval Research has contracts with three institutions—the University of Pennsylvania, Albert Einstein College of Medicine, and Ohio State University—to study the effects of high partial pressure of oxygen on animal nerve cells, mammalian lung tissues, and red blood cells.

● **Inert gases**—Narcosis—"rapture of the deep"—is well known for the drunken effects it produces in divers who attempt to breathe air at depths beyond 100 ft. It is produced, it is believed, because of the solubility of the



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nitrogen in the fatty components of nerve cells.

Helium, which has a solubility of about 4.5 times less than that of nitrogen, has proven to be quite effective for dives at depths since its first demonstration in 1962 by Dan Wilson, another diver now with Ocean Systems, Inc.

In March, however, the British reported that narcosis occurred with helium in dives around 800 and 1,000 ft. According to Dr. Workman, this gave a real pause to the Navy, since it was believed that the gas would be safe. Although the divers could function, the British reported, their performance was definitely affected. The British were able to perform open sea dives at 600 ft. with SCUBA equipment using helium, however, for useful periods up to one hour.

The British then turned to neon, which has interesting possibilities because it has a different distribution in the body tissues and fluids which makes it appear to resist narcosis. Using crude neon—four parts neon to one part helium—with oxygen, simulated 300-ft. dives were conducted. The British say the subjects did 25% better on mechanical tests, and 18% on arithmetic tests than with helium alone.

The Navy's EDU, according to Workman, has one cylinder of neon it will use in tests in the next few months. Because of the expense—$150 to $200 for 2 min. of gas—the group is planning very carefully how it will make use of the supply. Workman said they would like to get information in four areas: performance tests, narcosis at depth, decompression, and neon elimination during surfacing.

- **Neon disadvantages**—While neon is extremely expensive now, air refining companies report that if the need arose, production could be geared up to meet the demand. One drawback, Workman points out, is the density of the gas, which may make breathing extremely difficult. However, its use as an aid to helium elimination looks interesting, he said.

For this purpose, the diver would begin with helium, then at an intermediate point during the decompression he would switch to a neon mixture, speeding up the time necessary to eliminate the gas from his body.

Ocean Systems divers Arthur D. Noble and Robert W. Christiansen recently spent 30 min. at 650 ft. in an oxygen-neon mixture, with no measurable detrimental effects to their physical and psychological performance, and with normal voice communications. The remainder of the 48-hr. period of the simulation was spent at the same pressure, with helium and oxygen.

Ocean Systems also reports several actual dives below 600 ft. during the past few months, with breathing mixtures primarily composed of helium/oxygen, but with additives in a proprietary mixture. The company plans actual test dives at more than 600 ft. in October and simulated dives leading to a capability of 1,000 ft. by January, a spokesman said.

Project Makai Calls For Five Deep Labs

A PLAN to establish a series of undersea laboratories to study the man-in-sea problem as well as conduct other oceanographic and scientific investigations has been proposed by the Oceanic Institute and Lockheed Missiles and Space Co. under the name Project Makai. Industrial, scientific and government groups have been invited to participate.

Project Makai envisions a complex of at least one, and eventually five, laboratories at intervals from 50- to 600-ft. depth, with shore-based support and control, to be operated by members of the scientific and industrial community and government agencies. The idea appears to have the support of the state government of Hawaii.

Detailed plans for the laboratories have been drawn up with some assistance from the Navy. Interest has been expressed by scientific groups representing oceanography, seismology, geophysics, marine geology, marine ecology, physiology, and pharmacology.

Hydrogen, although the least narcotic gas, has virtually been ruled out by the Navy because of its flammability, Workman said. Xenon has very definite anesthetic effects. Of the other inert gases, krypton as well as xenon have been found to inhibit the normal growth pattern of *neurospora crassa.*

Basic research is being supported by the Office of Naval Research at the Linde Div. of the Union Carbide Corp., on the alterations in the function of cells and organs exposed to the inert gases.

One of the more advanced concepts of coping with the problem is the study by Dr. A. J. Kylstra, who has conducted experiments with mice and dogs in which they breathed a special water solution saturated with oxygen under pressure. A critical problem, he has found, is to clear the animals' lungs of water as they are surfaced, but some success has been demonstrated.

- **CO_2 poisoning**—A complication of substituting a lighter gas, such as helium, and then changing the normal pressure on the lungs is the fact that the human no longer has a good index of ventilation required for breathing. Carbon dioxide can build up—either from faulty equipment, or from over-exertion and failure to ventilate properly. Mental confusion and unconsciousness can result.

A study at the University of North Carolina is investigating the changes in flow characteristics down the branching airways of the lungs caused by increased gas densities. A facet of the Linde contract also includes CO_2 studies.

- **Decompression sickness**—The causes and mechanics of the bends—which brings on nausea, dizziness, paralysis, aeroembolism, and sometimes death—are still not fully known, according to Bond. Still, headway is being made toward increasing the safety of divers through the development of well-tested diving tables such as those recently completed by the EDU under Workman. Future work will consist of completing similar tables for helium/oxygen mixtures and increased depths.

A 75% reduction in time required for divers' decompression already has been accomplished through substituting continuous rather than staged decompression, Bond reported. With judicious use and calculated manipulation of as many as five inert gases, a still greater reduction in time may be possible, he said.

A study is now under way at the University of Florida that may yield information on the solubilities of gases in biological fluids under different conditions through a special device simulating the variables of gas combinations, pressures, time, temperatures and their effect in various tissue homogenates and fluids.

Equipment Problems

Concomitant with the solution of physiological puzzles is the development of better equipment to aid the diver in his extremely hazardous venture. The human being, in some respects, is far more efficient than any equipment at depth.

Testing of such equipment will take a good deal of research tank time at the EDU. Resistance to breathing from breathing apparatus with hoses, valves and various channels and regulators, especially under heavy pressures, can result in fatigue to the lungs, and finally carbon dioxide intoxication. Effort is going into development of equipment that will minimize the work the human must do to receive the breathing gas.

One area in which no immediate solution is foreseen is the gas hoses themselves. While a straight wall tube that will not kink has not been found, convoluted tubing induces breathing resistance.

The Navy is attempting to get away from helmet-type gas supplies to avoid the tremendous volumes of gas flow required. Inspiratory and expiratory breathing bags with molecular regulators are being substituted.

In the near future, tests will be conducted at the EDU of a new design of a Barolyme canister for CO_2 absorption. Designed by Navy researchers at EDU, the canister departs from the familiar cylindrical shape that has been found to create resistance by allowing turbulent flow as the breathing gas passes through. The new can is a flat, truncated trapezoid with a design that depends on size of channel to equalize and direct flow.

- **Controls**—A fairly recent advance that has been tested by the Navy is embodied in apparatus designed by the J. H. Emerson Co., which maintains a constant safe level of oxygen in the breathing mixture by means of an oxygen electrode sensor control. The device, according to Workman, shows promise to depths exceeding 1,000 ft.

A real need exists, however, for a carbon dioxide sensor that would operate reliably under pressure, taking samples and making instant analysis at depth. Although glass electrodes exist, Workman said, they distort at depth.

- **Decompression chambers**—The fact that saturation—the total amount of a gas mixture the body can absorb at a given pressure—occurs after approximately 24 hrs. was propounded by Bond in 1957 as a new approach to diving. His suggestion was to capitalize on the fact that once saturation occurs, the time required to decompress remains the same no matter how long the diver remains at depth.

Developments are going on in a number of places on decompression chambers—vessels in which the diver is transported to depth, and remains there until he is ready for the ascent, providing a refuge in emergencies. When the diver is ready to return to the surface, he enters the vessel, which is pressurized for the depth at which he was working.

Still at the diving pressure, the unit is mated to a shipboard circuit, for supply and monitoring purposes. Decompression can then take place under optimum conditions rather than in the water.

The ability to bring the diver to the surface has attractive safety features, with physicians readily accessible. In addition, the ship may need to move because of bad weather. The method also is economical, since the logistics of providing for the diver on-board are considerably less than they would be for supplying a submerged chamber.

Such devices are operational with Ocean Systems and are being tested by the Navy and Westinghouse. ■

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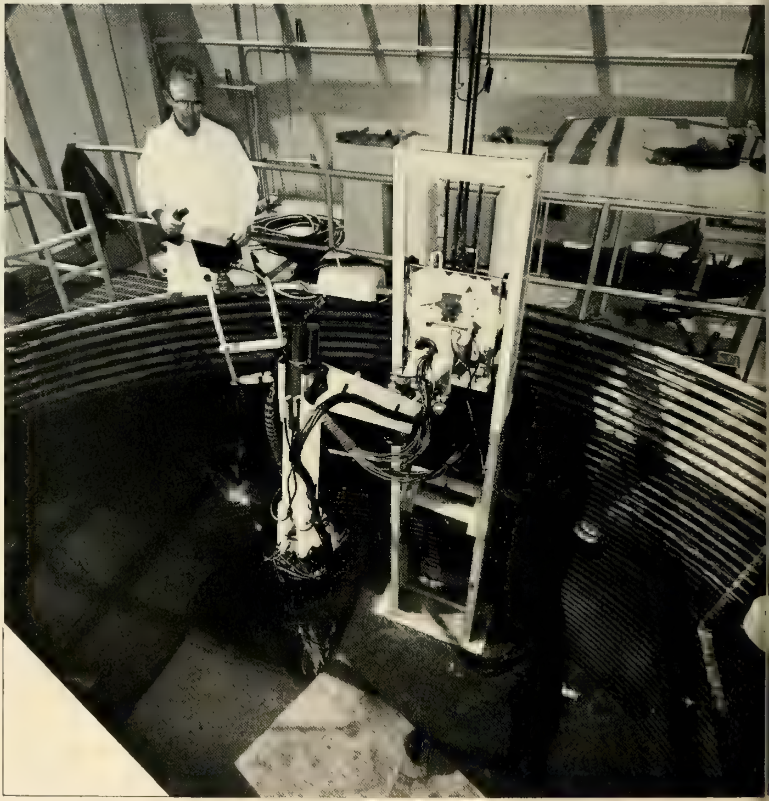
Soviet Surge Since World War II Challenges U.S. Oceanography Lead

by **Donald L. Zylstra** and **Charles D. LaFond**



TESTS PROCEED on undersea manipulators in development at North American Aviation's Autonetics Div. 15,000-gal. oceanology evaluation tank.

THE UNITED STATES continues to lead the world in both the quality and scope of its institutions concerned with the advancement of oceanography. But in the period since World War II, the Soviet Union has put new emphasis on its work in oceanography and may now seriously threaten the U.S. lead.

"In our knowledge and exploitation of ocean space, we are still ahead of the Russians and we must work hard to stay ahead," Rear Adm. Denys W. Knoll, Oceanographer of the Navy, emphasizes. "The Navy has always funded about 50% of the total national effort. In other words, our support has equalled that of all other agencies combined."

Adm. Knoll is being succeeded this week as Oceanographer of the Navy by Rear Adm. Odale Waters, former commander, Mine Force, Pacific Fleet.

Since 1958, Navy activity in oceanography has greatly expanded and its Office of Naval Research is responsible for a major part of the funding that has spurred the rapid growth of Government, university-sponsored and private institution effort.

The Navy program, coordinated by the Naval Oceanographic Office and participated in by the Office of Naval Research, the Bureau of Ships, the Bureau of Weapons, Bureau of Yards and Docks, the Special Projects Office and others, is part of an overall federal effort known as the National Oceanographic Program. This national effort is administered under the President's Office of Science and Technology through the Interagency Committee on Oceanography of the Federal Council for Science and Technology.

Agencies of the cabinet departments of Commerce, Defense, Health, Education and Welfare, Interior, State and Treasury all contribute to the National Oceanographic Program, either by funding of oceanographic work or by direct participation in development and research projects.

Outside the Navy, agencies from these departments include: the Army Corps of Engineers, the Coast and Geodetic Survey, the Weather Bureau, the Maritime Administration, the Bureau of Commercial Fisheries, Geological Survey, Bureau of Sport Fisheries and Wildlife; Bureau of Mines, National Science Foundation, Atomic Energy Commission, Public Health Service, Office of Education, Coast Guard and the Smithsonian Institution.

Of special interest in the sphere of technological research and development are establishments operated by the Navy and some dozen or more civilian institutions, most of them university related.

Outside the Navy, the two leading organizations are the Scripps Institution of Oceanography, La Jolla, Calif., now the world's leading single oceanographic complex; and the Woods Hole Oceanographic Institution, Woods Hole, Mass., world-renowned for its pioneer work in the study of the Earth's oceans.

Academic Institutions

Scripps Institution of Oceanography of the University of California is best described as "institutions within institutions," being the world's leading establishment in the oceanographic field.

Scripps offers strong programs in virtually all the oceanographic disciplines and areas of research and operates a fleet of ships for research at sea. The institute will soon take delivery of a new AGOR-type research vessel, the Thomas Washington, under a lease from the Navy's Bureau of Ships and funded by the Office of Naval Research.

Other vessels of ocean-going size operated by Scripps include: the Agassiz (180 ft.); Argo (213 ft.); Baird (143 ft.); Horizon (143 ft.); Oconostota (102 ft.); Paolina-T (80 ft.); Caprice (133 ft.); and the H.M. Smith (128 ft.).

- **Range of effort**—Leading activities in which more than 250 professionals at Scripps are now participating include: wave studies and recordings; tidal studies on the Pacific Coast and ocean islands; mechanisms of distribution and movement of sea water; development of deep-anchored observation buoys; military application studies, particularly those related to acoustics.

Scripps also conducts an extensive program in deep-sea soundings; investigations of micro-organisms and sediments; chemical analysis of sea water; determination of the age and distribution of sediments; studies of large-pattern circulation systems; research on Earth's geomagnetic field; and studies of ocean pressures with special tranducers placed on the bottom.

Dr. W. A. Nierenberg is the new director of Scripps, having succeeded Dr. Fred Spiess in July, 1965.

In addition to the laboratories and other structures at the La Jolla campus, Scripps is currently building and improving shops, moorings and a marine maintenance facility at Point Loma, Calif., adjoining the Naval Electronics Laboratory on land leased from the Navy.

Woods Hole Oceanographic Institution was organized in 1930, funded by grants from the Rockefeller and Carnegie Foundations. Its location at Woods Hole, Mass., made it a neighbor of the federal Marine Biological Laboratory and another laboratory facility operated by the United States Fish and Wildlife Service. Woods Hole's professional research staff now numbers more than 100 supported by several hundred more technicians, members of ships' crews, and clerical assistants. Dr. Paul M. Fye is director.

- **The plant**—Shore-based facilities include the main building, built in 1931, the Laboratory of Oceanography, constructed in 1954, and the Laboratory for Marine Sciences, readied for service in 1963. Supporting warehouse and storage facilities are housed on a 20-acre tract above the harbor area.

Of the seven vessels in the Woods Hole fleet of research ships, four—the 142-ft. ketch Atlantis, the 210-ft. Atlantis II, the 125-ft. former Coast Guard cutter Crawford and the Chain, a 213-ft. former Navy salvage ship—are operated in deep-ocean research. The institution employed both the Atlantis II and the Chain extensively in participating in the International Indian Ocean Expedition during the period 1961-1964.

Besides the ocean-going ships, Woods Hole also operates the 99-ft. Gosnold for work on the continental shelf in biological and geological research. For in-shore and estuary studies, the institution employs the 40-ft. Asterias and has acquired a small 20-ft. two-man submarine, capable of submerged operations to depths of 6,000 ft.

The original ketch, Atlantis, built in 1931 in Demark, is known worldwide for oceanographic activities and is believed to be the only research ship to have logged the impressive record of occupying more than 5,000 hydrographic stations in ocean research.

To complement this surface fleet, Woods Hole also operates two aircraft for meteorological support in connection with air-sea interaction studies, a small Helio Courier and a four-engine DC-4.

Over a 35-year history, Woods Hole scientists have published an impressive

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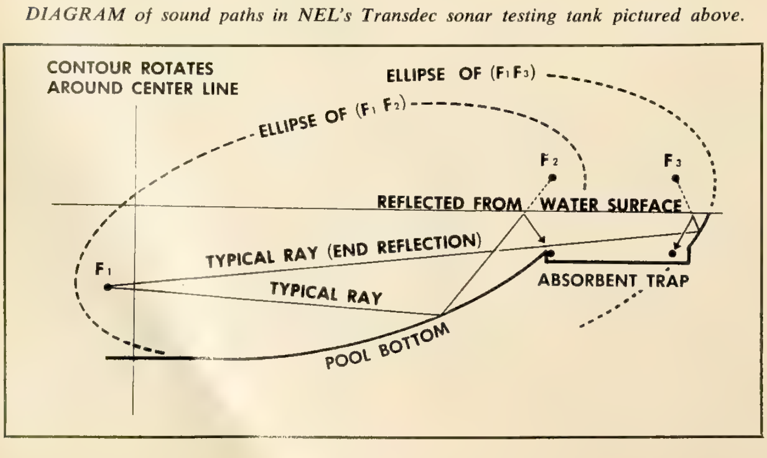
total of more than 1,400 major papers on oceanography. The institution's publication of these contributions to new knowledge of the world's oceans is now going forward at the rate of about 100 per year. Members of the Woods Hole staff also serve as professors at Massachusetts Institute of Technology, Harvard, University of Rhode Island, Columbia and other colleges and Universities in the New England area and elsewhere.

Like Scripps, Woods Hole has established a world reputation for excellence in all branches of oceanography. Important work at the institution emphasizes oceanic circulation studies; geology and the geophysics of world marine areas; development of oceanographic instruments, including free-floating and anchored deep-sea buoys; wave and tide research and the development of techniques for echo-ranging.

The *Lamont Geological Observatory of Columbia University* Palisades, N.Y., is headed by Prof. J. Lamar Worzel as acting director and is world-renowned for its collection of ocean-bottom core samples. The establishment is oriented principally toward geophysical research and carries on a large volume of seismic work, heat flow, magnetics and gravity studies, as well as directing investigations of ocean bottom sediments.

Lamont has the distinction of leading the oceanographic world in seismic refraction and reflection work, along with highly significant efforts in research in gravity and the Earth's magnetic field.

DIAGRAM of sound paths in NEL's Transdec sonar testing tank pictured above.



Ocean-going ships operated by Lamont include the Conrad, a 209-ft. AGOR-type vessel, and a 200-ft. sailing vessel, the Vema.

The *Institute of Marine Science of the University of Miami* is one of the U.S. institutions that has achieved the most rapid growth since World War II. Established in 1943 by its present director, Dr. F. G. Walton Smith, the facility's academic department of marine sciences now offers graduate training in the entire field of oceanography, ranking among the top three or four such graduate schools in the nation in terms of enrollment. The school has recently begun to offer one of the nation's first curricula in oceanographic engineering.

- **Direction of activity**—Miami's major emphasis is in the fields of marine biology and marine geochemistry, along with significant effort in physical oceanography and marine geology. The Navy's Bureau of Ships funds a program in underwater acoustics at Miami.

Miami's 177-ft. research ship, J. E. Pillsbury, has just returned from a research cruise in the Black Sea and the institution also operates the 75-ft. oceanographic vessel Gerda, plus other boats for research along the continental shelf and in estuaries along the coast.

Miami has been recognized for its extensive studies of the uranium series in its relation to Earth's oceans—also research dealing with tritium, carbon 14 and other radioactive elements—particularly as aids in understanding geochronology. Techniques developed in connection with radioactive elements research are being applied to understanding the mixing of water masses and the geochemical cycling of elements in the marine environment.

The *Department of Oceanography at the University of Washington,* Seattle, is headed by Dr. Richard Fleming. This institution is the only one in the U.S. providing a curriculum and instruction leading to an undergraduate degree in oceanography. Washington, along with Woods Hole and Scripps, was one of the nation's earliest non-government institutions to pioneer major effort in oceanography.

Important air-sea interaction studies are in progress at Washington. The school will benefit from the addition of a badly needed new building on the Seattle campus, funded by the National Science Foundation. An important program of biological studies is conducted by the department's laboratory station at Friday Harbor in the San Juan Islands.

- **Broadening horizons**—Washington's ocean research program, now largely confined to the northeastern Pacific and Arctic areas, is expected to broaden considerably with the delivery of a new AGOR-type ship, the Thompson. The 114-ft. Brown Bear is presently operational, along with the 65-ft. Hoh, used for student training and research.

The university's oceanographic department is involved in a proposal to equip Cobb sea mount, several hundred miles west of the Strait of Juan de Fuca, with an underwater data station in the form of a tower or buoy. The National Science Foundation funding has been earmarked for this project.

Washington researchers are studying he flow of the Columbia River for the Atomic Energy Commission and have lso done AEC-funded work related to ts "Plowshare" proposal for providing rtificial harbors through atomic blasts.

An applied physics laboratory at the niversity, supported by the Bureau of Naval Weapons, is involved in classified ork for the Navy.

The *Department of Oceanography nd Meteorology at Texas A&M,* headed y Prof. Horace Byer, is concerned rimarily with the oceanography of the Gulf of Mexico and the geological istory of the gulf. The school has a ood program of research in chemical ceanography, primarily oriented toward the organic side. Featured in the nstitution's growing facilities is a data enter set up as part of the worldwide GY oceanographic collection of data.

In physical oceanography, studies re being made of storm-induced water evels in attempts to predict high tides aused by hurricanes. Main laboratories and academic facilities are located

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at College Station, Tex., with berthing facilities for oceanographic ships at Galveston.

Texas A&M also operates a facility at Panama City, Fla., using two oceanographic towers maintained by the Naval Mine Defense Laboratory for gathering research data. Seismic work is an important effort, related to refraction and reflective properties of both sediments and salt dome formations.

Texas operates the 180-ft. ship Alaminos and a number of smaller vessels from its Galveston location on the gulf.

The *Narragansett Marine Laboratory of the University of Rhode Island,* Kingston, R.I., has grown from a small facility mainly interested in biological research. Main impetus has been gained over the past four years by the completion of a modern laboratory in 1960. The National Science Foundation is funding another laboratory in support of further expansion. Dr. John A. Knauss is dean of the institution.

Students in the graduate school of oceanography have the use of the marine laboratories and pursue their studies at sea aboard the 180-ft. research vessel Trident.

Narragansett has compiled a unique library of biologically produced underwater sound tapes—the product of the lifetime research of Dr. and Mrs. Charles Fish. Other Narragansett research includes work on ocean currents, in chemical oceanography and marine geology.

The *Chesapeake Bay Institute of the Johns Hopkins University,* Baltimore, is affiliated with the school's department of oceanography and maintains a field laboratory and berthing facilities for its vessels at Annapolis, Md. Dr. Donald W. Pritchard is department chairman and director of the institute.

The institute has obtained funds to build a 150-ton catamaran-hull shallow-draft vessel to augment its small research vessels.

- **Pollution probed**—Estuary research, concentrating on flushing rates and pollution problems, is given primary attention at Chesapeake Bay Institute. Director Pritchard is a world authority on circulation and mixing in estuaries.

Chesapeake is also involved in a study of the growth of gravity waves over short fetches and in research into the nature of coupling mechanisms between the surface of the sea and the atmosphere.

Massachusetts Institute of Technology is a school concentrating on the training of oceanographers as its contribution to this field. Many of the people on its staff are Woods Hole oceanographers and MIT has a close working relationship with that institution, programming research at sea through Woods Hole for both its staff and students. Now just more than four years old, MIT's oceanographic effort is growing steadily under the direction of Dr. Robert R. Schrock, head of the department of geology and geophysics, and Dr. Henry G. Houghton, head of the department of meteorology.

Much of MIT's emphasis is on theoretical physical oceanography and geophysics. The school also has a highly-respected chemical oceanography program.

The *Department of Meteorology and Oceanography, New York University,* leads the oceanographic field in the study of waves, ocean turbulence, and other aspects of water motion and circulation. Chairman of the department is Prof. James E. Miller.

NYU's research effort has produced some of the outstanding gravity wave scientists in the nation.

The school operates the Kyma, a 65-ft. oceanographic vessel.

The *Department of Oceanography of Oregon State University* with facilities at its Corvallis, Ore., campus and at Newport, Ore., has enjoyed a phenomenal growth since World War II under the direction of its founder and department chairman, Dr. Wayne V. Burt. The school has advanced to a place among the top three oceanographic institutions in the U.S. in terms of the number of students enrolled.

Oregon has strong programs of instruction and research in physics, oceanography, marine geophysics and a growing effort in chemical oceanography.

New buildings, both on the Corvallis campus and 56 miles away at Newport, have expanded the school's physical plant. The new facility at Newport includes docks, a laboratory and a lecture hall. Vessels for ocean research include the 180-ft. Yaquina. The 80-ft. Acona has been made available to the University of Alaska.

The *Institute of Marine Science of the University of Alaska,* Fairbanks, has a growing Arctic oceanographic research potential under the leadership of Director Dr. Donald Hood. In addition to facilities on its campus at College, Alaska, near Fairbanks, the institute also operates the Douglas Marine Station near Juneau. The 80-ft. research ship Acona has been acquired from Oregon State University.

The department of meteorology and oceanography and the *Institute of Geophysics of the University of Hawaii* concentrate on the academic and research aspects of oceanography, respectively. Dr. Vernon E. Brock currently heads the institute of geophysics and Dr. Richard A. Barkely, the department of meteorology and oceanography. Dr. Richard G. Bader, presently program director for oceanography for the National Science Foundation, will take over Jan. 1 as the new chairman of Hawaii's oceanography department and will also be in charge of marine research.

The university also is associated with the Hawaii Marine Laboratory at Coconut Island and the Hydrodynamics Laboratory at Kewalo Basin. Ocean research vessels operated by the school include the 92-ft. Territu.

U.S. Navy

In the realm of Government oceanographic effort, by far the largest complex of facilities is operated in the Washington, D.C., area by the Naval Oceanographic Office (NAVOCEANO). Formerly the Naval Hydrographic Office, the establishment's name was

NEL's shallow-water tower provides an extremely stable platform from which to make a variety of oceanographic studies. Closed-circuit television is used.

changed by act of Congress in July, 1962. The new office incorporates all the former hydrographic functions, plus a growing list of activities specifically related to Navy's interest in science and technology related to oceanography.

- **Scope**—Navy's Washington oceanographic establishment now employs more than 2,000—more than 700 on the specifically oceanographic side and about 1,500 in hydrographic activities.

Oceanographic functions are organized under three departments of the Oceanographic Office: the Marine Sciences Department; Oceanographic Instruments Center; and the Surveys Department. Physically, activities in these departments are distributed in locations at headquarters of the Oceanographic Office, Suitland, Md., and at the Washington Navy Yard, Washington, D.C.

The *Marine Sciences Department*, headed by J. J. Schule, Jr., acting director has three divisions: Oceanographic Analysis; Oceanographic Prediction; and Oceanographic Development. The Analysis Division is primarily a publications production agency, making oceanographic publications available to any qualified user.

The Prediction Division is concerned with forecasting ocean temperatures in relation to depth, with movements of water masses and columns and wave heights. ASWEPS (anti-submarine warfare environmental prediction system) comes under this division's direction. Presently entirely a developmental effort, it is designed to make the data-producing efforts of forecasters and oceanographers available to the fleet.

In addition to training in ASWEPS techniques, the Navy hopes to provide the fleet with facsimile charts of the oceanographic environment. This division also has an ice studies branch in the Arctic and Antarctic, supporting the national defense effort.

- **Research in ice**—The Oceanographic Office sent a team of experts to the Antarctic last year for the first time to predict ice conditions.

A program in ice research has been operating in the Arctic regions for many years. An aircraft, known as the "Birdseye" plane, is used for flights over the ice in the Central Arctic Basin.

The Prediction Division was also involved with the Navy's floating ice island project, Arlis II, an Office of Naval Research-sponsored operation. Ocean wave forecasting is another concern of the division.

The Marine Sciences Department's Developmental Division has supported Navy's AUTEC (Atlantic Undersea Test and Evaluation Center) program in the Tongue of the Ocean off Andros Island in the Bahamas by collecting environmental data for the instrumented undersea area.

Another concern of the Developmental Division is a continuing long-range sonar project effort entailing research on how ocean environment affects long-range sonar propagation.

The division's marine geophysical survey is being conducted under two contracts—one awarded to Alpine Geophysical Associates and the other to Texas Intruments, Inc.

The Oceanographic Office's *Oceanographic Instruments Center* is headed by Director Gilbert Jaffe and also conducts its operations through three divisions: the Testing Division; Development and Engineering Division; and Engineering Services Division.

Instruments and data-collection systems are forwarded from industrial manufacturers and from Navy in-house facilities to the Testing Division for testing and evaluation.

Key project of the Deveopment Engineering Division is the "Shipboard Survey System," now being installed aboard the USMS Silas Bent (AGS 26).

Repair and calibration of oceanographic instruments have been assigned the Engineering Services Division as its prime responsibiity.

The *Surveys Department*, operating under the direction of B. C. Byrnes, has two operating divisions, the AGOR Division and the Ocean Surveys Division.

- **Ship administration**—As its name implies, the AGOR Division is concerned with the Navy's AGOR (auxiliary general oceanographic research) type vessels. The Navy currently plans six or seven of these vessels, to be operated by the Military Sea Transportation Service (MSTS) under technical control of the Naval Oceanographic Office, which provides the technical personnel and projects aboard.

Scheduling of AGOR ship operations is the responsibility of the Naval Research Laboratory (NRL) on the Atlantic coast and the Naval Electronics Laboratory (NEL) on the Pacific coast.

The Ocean Surveys Division provides the personnel who take oceanographic tools to sea in all of the Navy's efforts to collect data.

Oceanographic research and technological activities are distributed throughout the bureaus of the Navy, one of the largest efforts being conducted though the Bureau of Ships. The important Arctic underseas research program begun by this bureau in 1948 under the leadership of Dr. Waldo K. Lyon has been largely responsible for making under-ice submarines feasible.

As in the case of the Bureau of Naval Weapons' largely classified effort, a majority of the Bureau of Ships' oceanographic programs are justified in

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support of acoustics and anti-submarine warfare (ASW).

Other BuShips programs include NEL's completely instrumented tower off Ocean Beach, Calif. Equipped to support its research crews comfortably for periods of 30 days, the station is making highly accurate measurements of water particle motion, gas content, visibility, biological changes, marine life and sediment movements. Present effort emphasizes the understanding of internal waves and their associated phenomena, such as surface slicks in relation to tides and other forces.

Both NEL and the Underwater Sound Laboratory (USL), San Diego, Calif., have established programs for oceanographic and acoustic studies aboard Navy's AGOR-type research vessels under Oceanographic Office control.

● **Out-of-house work**—Closely associated with in-house laboratory programs in AGOR vessels are two contracts, one with Lamont Geophysical Observatory and the other with Miami's Marine Laboratory.

At Lamont, research studies are concentrating on sedimentation processes in the deep ocean and the sub-bottom geological structures, studies in acoustic properties and physical properties, using soil mechanics techniques.

At Miami's Marine Laboratory, the BuShips program includes ambient noise measurement research on Bimini Island off the Florida coast.

The bureau also maintains one-man-year efforts at other laboratories, including: identification and understanding of micro-organisms that precede and contribute to corrosion—Navy Applied Science Laboratory, Brooklyn Naval Shipyard; studies in the proper programming of sea-keeping facilities, to simulate actual sea and swell in model tests—David Taylor Model Basin, Carderock, Md.; oceanographic studies in support of a high-pressure facility for simulation of deep-sea conditions—the Marine Engineering Laboratory, Annapolis, Md., the Navy's oldest laboratory.

Pressure spectrums in shallow water are being studied at the Navy's Mine Defense Laboratory, Panama City, Fla., along with pressure changes caused by seitches, tidal effects, weather fronts and other phenomena connected with passing weather fronts.

Equipment for the measurement of natural radioactive background in the sea is being developed at the Navy's Radiological Defense Laboratory at Hunters Point in San Francisco Bay.

● **Electronics responsibilities**—One of the pioneers in modern U.S. oceanographic research and in the development of instruments and equipment used to support the whole field of oceanology is the U.S. Navy Electronics Laboratory, San Diego, Calif.

The station became a major facility in 1940 with the establishment of the U.S. Navy Radio and Sound Laboratory. Later, in 1941, the University of California Division of War Research was established there and the two groups eventually were combined to make up NEL in November, 1945.

A major electronics facility largely supported by the Bureau of Ships, it now includes a total plant valued in excess of $25 million and covering a total area of 1,300 acres throughout the northern hemisphere.

In addition to its large real estate holdings on Point Loma, NEL's other installations are 600 acres on Cape Prince of Wales, Alaska (Arctic Ocean research), and a facility at Land Pend Oreille, Idaho.

While much of NEL's efforts necessarily are directed throughout the entire spectrum of Navy electronics (except fire control) and acoustics, the output from these various technologies may be drawn on for support of the facility's ocean sciences effort.

A fleet-type submarine, several ocean-going surface research vessels and a sailing yawl are available for data collection and experimental use. Until recently, the bathyscaphe Trieste II was operated by NEL scientists. The Cousteau diving saucer, leased by Westinghouse, has been operated extensively by NEL personnel and experts there are playing a major role in design and development of a new U.S.-built bathyscaphe (sometimes unofficially referred to as Trieste III).

● **Deep-diving interest**—Now lacking a deep-diving vehicle, NEL is expected to lease the Westinghouse Deep Star, a 4,000-ft.-depth submersible, late this year. It is also awaiting completion of the Lockheed Deep Quest and may lease that vehicle because of its relatively large payload capability. The Reynolds Aluminaut, once Navy certified, also may be sought by NEL for lease for deep-water research.

Among the specialized instrument facilities at NEL's Point Loma station are an oceanographic shallow-water research tower located about 1 mi. offshore and TRANSDEC, a unique Transducer Evaluation Center.

The platform stands about 87 ft. off the ocean floor and about 27 ft. above the water surface at mean tide level. The main deck is a concrete slab, measuring 22 x 34 ft., which supports a 13-x-23-ft. instrument shelter. Three 50-ft. booms are provided for lowering instruments.

The latter is a large acoustic anechoic tank measuring 200 x 300 ft. and 38 ft. deep at its maximum point. A central bowl measuring 160 ft. in diameter is surrounded by a flat sound-trap area.

The bottom of the bowl, a canted ellipse, is such that when sound is generated at the lower ellipse focus, it is directed toward the second focus, reflected between the bowl bottom and the water surface, is deflected over the bowl bottom and the water surface, is deflected over the bowl lip and dies in the outer trap without reverberating back to the source area.

● **Charting temperatures**—Great strides have been made by NEL in measuring ocean temperature structure. A 900-ft.-long thermistor chain, developed by NEL's Dr. Eugene C. LaFond, has been installed aboard the lab's oceanographic research ship, USS Marysville (EPCER 857).

Lowered from the ship's stern and dragged at slow speed, the instrument provides temperature measurements at 27-ft. intervals to depths of about 800 ft. Thermistor beads are scanned electronically every 10 seconds and the data are recorded on strip charts to show the depths of constant temperatures plus surface temperature and the maximum depth of observations.

By employing an old World War I Army 12-in mortar emplacement at Point Loma, NEL has built an "arctic pool" for use in studying sea-ice physics. The pool measures 30 x 75 x 16 ft. Under the pool floor is a 9-ft.-dia. x 48-ft.-deep circular chamber. An access passage is provided to reach the pool floor and the lower test chamber.

In the pool area, ice more than 7 ft. thick can be found under simulated blizzard conditions. The lower chamber can be used to test under-ice submarine equipment and instruments. The whole test unit is housed within a 200-x-900-ft. metal building Through the use of a complex cooling/heat exchanger system, temperatures above the ice can be lowered to −80°F while the water below the ice is held to an even 29°F.

● **Weapons development**—The Naval Ordnance Test Station in Pasadena, Calif., is responsible for developing and testing underwater weapons systems and it will play a key testing role in the Navy's Deep Submergence Systems Project.

In addition to its extensive skills and instrumentation developed in the weapons test programs, it also employs the support ship YFU-53, a greatly modified LCU, for its underwater activities. In addition to its considerable test and evaluation instrumentation, it carries the latest in underwater detection, navigation and sensing equipment and is provided with a 6-ton bridge crane for handling submersibles.

Finally, the craft carries a unique recovery platform containing sensors and a noose arrangement by which small vehicles or objects can be located, snared and brought to the surface from depths to 2,500 ft. The device also has proved effective for use in pressure-testing large objects.

- **Aerospace industry alert**—The awakening of the aerospace industry to the potential of a burgeoning U.S. oceanological industry is best represented not only by its increasing in-house R&D efforts but also by its growing investment in fixed research facilities.

The following typify this expansion and also indicate the caution being employed. Wherever possible, firms have stated that they intend to use skills, equipment and support facilities already existing. Duplication of data processing systems, for example, will be avoided as long as practicable. Staffs at the oceanographic facilities will be held to a minimum of specialists, with the emphasis on broad ocean science experience. Specialists, industry leaders say, can be drawn as needed from other company divisions. Space permits mentioning only a few typical industry efforts here. Many others are equally important within this growing field.

Lockheed Aircraft Corp. recently completed negotiations with the San Diego Port Authority to lease 2.7 acres of land on the city's salt water channel. A 12,000-sq.-ft. structure on the site will serve as the firm's newly created Lockheed Marine Laboratory.

Its initial staff will be drawn from he Lockheed-California Co. and the Lockheed Missiles & Space Co. Total personnel planned within the next several years probably will be held to from 30 to 40, according to company officials.

The laboratory will serve as a common facility for all Lockheed divisions engaged in marine research or hardware development programs.

LMSC, which is currently developing the Deep Quest submersible, will build its own high-pressure hydrostatic est facility at Sunnyvale, Calif. It is xpected that Deep Quest sea trials will be directed from the new lab in San Diego.

The prime user initially of the facility will be Lockheed-California's oceanographic ship, Sea Quest. Also, hat division will perform the bulk of its $2-million Navy study of underwater transmissions and signalling at he new lab.

Lockheed Propulsion Co., currently engaged in developing new underwater propulsion techniques and systems for ubmersibles, also will use the San Diego aboratory.

The seat of the Westinghouse oceanology effort is in its Underseas Div. with eadquarters near Baltimore. It will uild a multi-million-dollar facility for esearch, test and evaluation on a 115-acre site on the Chesapeake Bay near Annapolis, Md. The facilities are being designed to house up to 500 engineers and support personnel ultimately. A docking facility will be able to accommodate vessels of up to 300 ft. with a 40-ft. beam and 18-ft. draft.

A natural lake on the property will be dredged to provide a quiet body of water of 30 acres with depths varying from 25 to 90 ft.

- **Sales outlook**—Since the firm estimates that its underseas efforts will account for 10% of its total sales by 1975, it also has a second oceanology facility underway on the West Coast near San Diego. There the firm will test and operate its new Deep Star series of submersibles and will also provide support for surface-type oceanographic vessels.

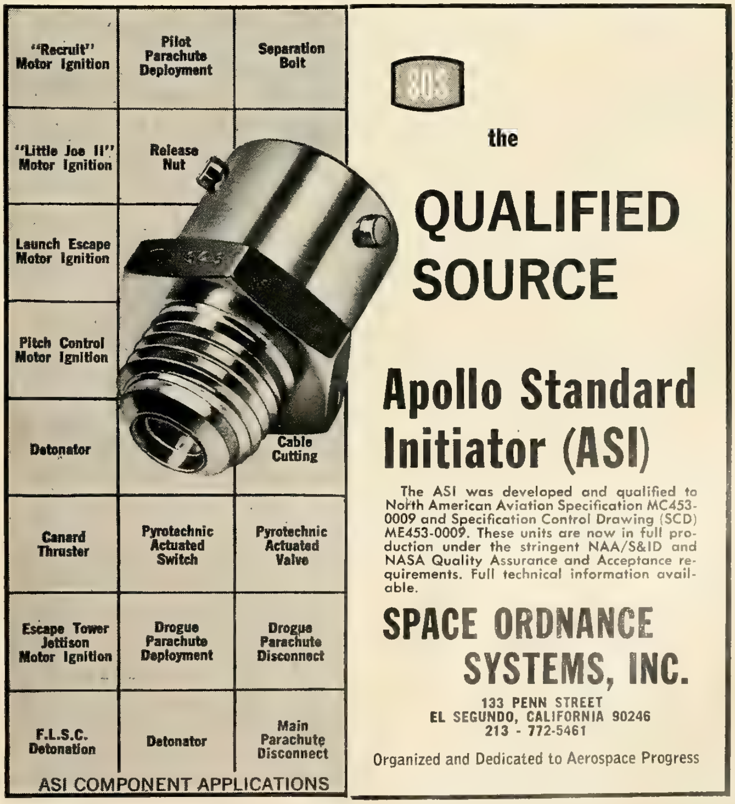
The Underseas Div. is directed by General Manager Jack Clotworthy; the oceanography subdivision is managed by Joe Laing; Deep Star project manager is Ben Moore.

With well over 60 years experience to date, the Electric Boat Div. of General Dynamics is not only a pioneer in the submersible field but also one of its leaders. R&D and manufacturing for both surface ships and submersibles at Quincy, Mass., and Groton, Conn., are extensive and complete. To list all the facilities available at these two huge facilities would be impractical since they encompass everything from materials testing to drydocks and pressure tanks.

In summary, Quincy provides more than 2 million square feet of ship-construction facilities and more than ⅓ of a million square feet of fabrication and test facilities. The Groton facility occupies more than 110 acres of space with 1.5 million square feet of covered area, including R&D and manufacturing buildings, floating drydock, marine railway, graving dock, and nuclear refueling facilities. EB's oceanographic submersible effort is centered at the Groton installation, where the Star series is being developed.

In addition, a new Marine Technology Laboratory has been formed in San Diego (adjacent to the new Lockheed facility). There, the Star submersibles will be tested, as will new oceanographic instruments.

Data processing support, at least initially, will be provided by GD's Convair facility in San Diego. Specialists will be drawn as required also from that facility and from the division's facility in suburban San Diego (formerly called GD/Astronautics). Personnel will probably level off at from 30 to 40 during the next several years, according to GD officials. ■



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names in the news

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James W. Plummer: Appointed vice president of Lockheed Missiles & Space Co. He has been assistant general manager of the Space Systems Div. since 1962.

Joseph S. Bartos: Appointed vice president and assistant general manager, corporate systems management, with Avco Corp.'s Research and Advanced Development Div. He has complete program management responsibilities for the division's present *Minuteman* obligations.

C. K. Fulton: Named manager of General Electric Co.'s *Nike-X* operation at the heavy military electronics department. Named to succeed him as manager of advanced projects development was **Major A. Johnson.**

Dr. William T. Russell: Named technical program chairman for the 1966 Winter Convention on Aerospace & Electronic Systems, sponsored by the IEEE. He is associate director of spacecraft systems program management, TRW Systems Group, TRW Inc.

Richard P. Castanias: Appointed director of Houston Operations for Informatics, Inc. He was formerly with the Univac Div. of Sperry Rand Corp.

George Shimabukuro: Joined the staff of Electro-Optical Systems, Inc., a subsidiary of Xerox Corp., as a senior engineer in the company's program management and systems engineering group.

Paul M. Canick: Promoted to research director of the Research and Analysis Div. of Booz, Allen Applied Research, Inc. He was previously a project engineer with the firm.

Robert F. McIntosh: Named general manager of the newly-formed Management Control Systems Div. of Planning Research Corp.

Dr. George H. Brown: Elected executive vice president, research and engineering, of Radio Corp. of America. **Howard L. Letts** was also elected executive vice president and controller of RCA.

Lt. Col. James V. Powers (USAF, Ret.): Named assistant to the president of Technical Operations Research, the research and development division of Technical Operations Inc.

Dr. Burton I. Edelson: Leaving the National Aeronautics and Space Council for reassignment with the Navy. He is a commander in the Navy and has been on special assignment to the council since 1962.

William J. Ledbetter: Elected secretary and general counsel of Honeywell Inc. He has formerly been on the legal staff of General Electric Co.

Frederic M. Oran: Named vice president of the Special Contracts Dept. of Industrial Acoustics Co., Inc.

John B. Farese: Promoted to division vice president of Electronic Components and Devices, Radio Corp. of America.

Ascher H. Shapiro: Named head of the Department of Mechanical Engineering at the Massachusetts Institute of Technology.

George J. Harris: Appointed a senior engineer at Technical Measurement Corp.'s Syber Div.

Girard F. Oberrender, Jr.: Elected vice president of research and development of General Laboratory Associates, Inc. Also elected to vice presidencies were **Lawrence A. DeMellier,** marketing, and **Howard P. Rowell,** engineering.

William H. Dana and Capt. William J. Knight: Named to fly the *X-15* rocket-powered aircraft. They are the 10th and 11th men chosen for this task. Both have been serving as chase pilots for the *X-15.*

Neil A. Montone: Named director of marketing for Lockheed Electronics Co., Military Systems Div., and **Harvey J. Bradfield** was named assistant director. **Chalmer E. Jones** was named director of marketing for the firm's Avionics and Industrial Products Div.

Raymond P. Lansing: Celebrated his 50th year with The Bendix Corp. He is vice president and group executive with responsibility for five of the corporation's manufacturing operations.

James C. Rome: Elected vice president-finance, and treasurer of Hi-Shear Corp. He will continue to serve as a director and controller.

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16th International Astronautical Congress, sponsored by the International Astronautical Federation, Athens, Greece, Sept. 12-18.

Thirteenth Annual Joint Engineering Management Conference, sponsored by American Institute of Aeronautics and Astronautics (AIAA), Institute of Electrical and Electronics Engineers (IEEE), American Society of Mechanical Engineers (ASME), and others, Roosevelt Hotel, New York City, Sept. 13-14.

Thermophysics Specialist Conference, sponsored by AIAA, U.S. Naval Postgraduate School, Monterey, Calif., Sept. 13-15.

Electrical Insulation Conference, sponsored by U.S. Navy Bureau of Ships and Allis-Chalmers Mfg. Co., New York Hilton, New York City, Sept. 13-16.

Symposium on Structural Adhesives Bonding, sponsored by Picatinny Arsenal (U.S. Army Munitions Command), Stevens Institute of Technology, Hoboken, N.J., Sept. 14-16.

Advanced Incentive Contracting, sponsored by National Defense Education Institute (NDEI), Washington, D.C., Sept. 15-17.

Astrodynamics Specialist Conference, sponsored by AIAA and Institute of Navigation, U.S. Naval Postgraduate School, Monterey, Calif., Sept. 16-17.

National Power Conference, sponsored by IEEE and ASME, Sheraton-Ten Eyck Hotel, Albany, N.Y., Sept. 19-22.

Fifth Annual National Conference on Environmental Effects on Aircraft and Propulsion Systems, sponsored by U.S. Naval Air Turbine Test Station, Nassau Inn, Princeton, N.J., Sept. 20-22.

Systems Engineering Exposition and Conference, McCormick Place, Chicago, Sept. 20-23.

International Conference on Thermionic Electrical Power Generation, sponsored by Institution of Electrical Engineers, London, England, Sept. 20-24.

Advanced Incentive Contracting, sponsored by NDEI, Los Angeles, Sept. 21-23.

Fifth Annual Bio-Environmental Engineering Symposium, sponsored by the USAF School of Aerospace Medicine, Brooks AFB, Tex., Sept. 21-24.

1965 IEEE Conference on Military Electronics (MIL-E-CON 9), Washington Hilton Hotel, Washington, D.C., Sept. 22-24.

13th Annual Communication Conference, sponsored by IEEE, Cedar Rapids, Ia., Sept. 24-25.

Advanced Incentive Contracting, sponsored by NDEI, New York City, Sept. 28-30.

1965 Fall National Symposium of the Society for Information Display, Commodore Hotel, New York City, Sept. 29-30.

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The Industry Within

WHILE ASTRONAUTS Gordon Cooper and Charles Conrad were riding *Gemini 5* to the conclusion of a spectacularly successful eight-day mission, they chatted by radiotelephone with astronaut Scott Carpenter. This in itself would not have been unusual but for the fact that Cmdr. Carpenter was not at one of the tracking stations of the worldwide *Gemini* net but 205 feet under the surface of the Pacific Ocean in Sealab II.

There is more than a casual connection between the nation's space and underwater programs. Like space, the undersea area has been explored only in the most tentative way. Sealab II, located off the coast at La Jolla, Calif., is one of the early efforts to test the ability of man to live and perform usefully in the underocean environment.

Like space, the undersea region offers national resources of great potential. It is time for the U.S. to embark on a determined effort to exploit that potential already known to exist and to explore that which still is unknown.

One reason for urgency is that the U.S. is signatory to an international agreement which, since 1964, grants each nation the right to explore and exploit its continental shelf to a depth of 600 feet *and deeper where the capability exists to do so.*

The implication of the last clause is that other nations have that right where the adjacent nation lacks the capability.

As a witness recently told a Congressional committee, this may well be the starting gun of an international race to develop deep-ocean technology. We do not believe it necessary for the U.S. to engage in still another expensive race with the Soviet Union merely for the sake of competition but we feel equally strongly that the nation should not neglect an area of such interest and potential.

The missile/space industry has been in the vanguard of efforts to establish a worthwhile effort in oceanology, defined for the special report starting on page 23 as the application of advanced technology to ocean engineering. Some may ask why an industry which developed its know-how in missiles and space is the logical one to undertake the exploration and exploitation of the oceans.

The reasons are numerous. One can look at the requirement to meet reliability standards identical to those of space equipment or at the requirement for space technologies such as microelectronics. The materials field, in particular, is one in which Space Age knowledge is being put to immediate use for underwater vehicles. Efforts to establish an environment for survival of man in an unfriendly medium are quite similar.

Power requirements are familiar. The Atomic Energy Commission, which developed radioisotope nuclear power packages for space use, now is engaged in the development of SNAP-21 and SNAP-23 for marine application.

Above all, the need for systems management of the type developed for large aerospace programs is outstandingly apparent. One of the most immediate requirements of the oceanology program is for adequate data handling, analysis and decision.

This is, indeed, a case of an industry within an industry.

It all would be academic, of course, if the government had not already indicated its readiness to fund ocean engineering projects at a level which makes industry participation worthwhile. Texas Instruments, for example, has just received a $5.6-million contract for a major oceanographic survey. Other industry firms see a substantial future in oceanology and are making suitable investments of company funds.

WE HAVE ATTEMPTED to indicate in this special report the extent of the existing effort in oceanology, its present and future problems, and its promise. It appears to us that one of the immediate problems is one of adequate legislation.

Establishment of the Interagency Committee on Oceanography (ICO) to coordinate the efforts of 22 separate government agencies was a major step forward. But it does not go far enough.

One answer to the problem is found in the Magnuson bill recently passed by the Senate, which calls for establishment of a high-level national council on marine resources to be chaired by the Vice President. It would include a number of Cabinet members, among them the Secretaries of State, Navy, Interior, Commerce and Health, Education and Welfare. This council would be supplemented by an Advisory Commission including industry and scientific members.

We believe this elevates the program to too high a level, where it will be the responsibility of men who do not have the time to devote to it. The main advantage of the Magnuson bill is that it is the only oceanographic bill to have passed the Senate. A similar bill has been introduced in the House by Rep. Dante Fascell (D-Fla.)

Nor do we see a need for the so-called "wet NASA." There already is a legitimate although widely scattered effort in oceanology under way in a great number of agencies. The lack of any significant interest whatever—which made the establishment of the National Aeronautics and Space Administration attractive in the space field—is not the case here.

A more sensible approach, in our opinion, would be a strengthening of the powers and budget of the ICO together with establishment of the Presidential Advisory Commission called for in the Magnuson bill. This, of course, would require safeguards against total domination of the program by the Navy due to its position as the single most powerful member. Passage of the Fascell bill, thus amended, would assure speedy consideration with the Magnuson bill in joint committee.

William J. Coughlin

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(fill in your project here)

Write or phone Bill Thorn, Manager of Undersea Technology at

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missiles and rockets

THE WEEKLY OF ADVANCED TECHNOLOGY

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Silo-Launched Soviet ICBM Blasts Off

DDR&E Shuffle De-Emphasizes

Scramjet Flight Tests Slated for

Latest Edition of M/R's Astrolo

PUBLICATION

In outer space, all the pieces better fit.

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At United Technology Center, our capabilities include intelligent coordination with other contractors and suppliers. Our technology—propulsion. Solids, liquids, hybrids, ranging from powerful boosters to delicate variable-thrust motors for landing and docking.

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United Technology Center DIVISION OF UNITED AIRCRAFT CORPORATION

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missiles and rockets
THE WEEKLY OF ADVANCED TECHNOLOGY
Volume 17, Number 11 September 13, 1965

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THE COVER

Soviet ICBM leaves silo in single frame of documentary motion picture film showing Russian missiles in action. Several of the photos were published in the June issue of the Soviet magazine Ogonyok with an article written by three army officers. See page 16 for additional photos.

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47,000 copies this issue

LOOK WHAT'S HAPPENED TO MARQUARDT'S "FLYING STOVEPIPE!"

SCRAMJET OPENS NEW ERA FOR AIRBREATHING PROPULSION

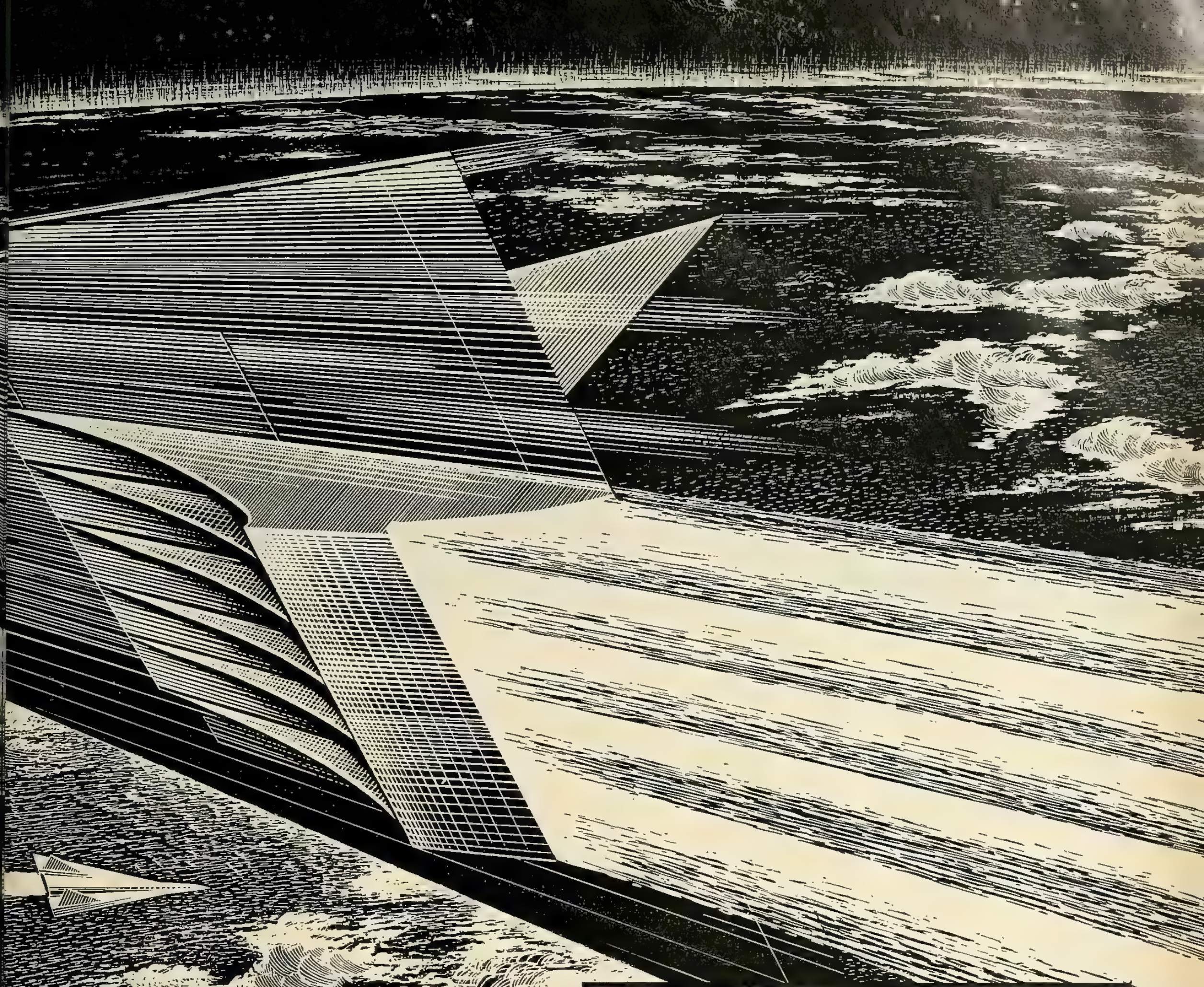
FIRST, THE SUBSONIC RAMJET: Marquardt produced America's first operational subsonic ramjet in 1945. A clean and simple aerodynamic tube, it was aptly described as a "flying stovepipe."

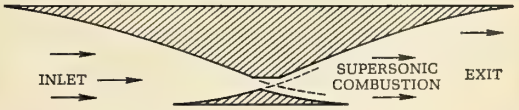
THEN, THE SUPERSONIC RAMJET: To achieve supersonic capabilities, the ramjet engine became necessarily more complex. Diffusers, sensors, inlets, controls, grids, flame holders, exit nozzles — each representing a significant development — served to improve the efficiency and quality of internal air flow, compression, combustion, and thrust. This engine today powers the Bomarc interceptor missile. The supersonic ramjet engine, which has no rotating parts in its operating cycle, remained a relatively simple airbreathing propulsion system — but it no longer resembled the old "flying stovepipe."

AND NOW, SCRAMJET: Today, airbreathing technology has entered the era of SCRAMJET—a propulsion system using to full advantage the ramjet's inherently simple fixed geometry design for hypersonic acceleration and cruise performance—a return to the classic simplicity of the "flying stovepipe."

THE SCRAMJET MISSION: SCRAMJET, the supersonic combustion ramjet engine, performs most efficiently at flight speeds above Mach 6; its range capability expands rapidly as its speed increases. Potential new applications for both space and military missions are under study. These include: hypersonic cruise aircraft, recoverable launch vehicles, and defense and tactical missile systems.

ADVANCED RAMJET CAPABILITY: For two decades, The Marquardt Corporation has pioneered simple airbreathing propulsion systems. Marquardt's capability has been enhanced materially by the recent amalgamation with the General Applied Science Laboratories (GASL), Westbury, New York. Under the direction of Dr. Antonio Ferri, GASL has made significant contributions to the advancement of and the renewed interest in airbreathing propulsion, particularly in the hypersonic regime.





HOW SCRAMJET WORKS

In the classic ramjet the incoming air is slowed down to subsonic speeds, mixed with fuel, and burned in a low velocity combustor air stream. In the Scramjet, the total process is supersonic: air flow, mixing and combustion. The Scramjet, offers a higher performance capability over a broad Mach range, reduced cooling requirements, fixed geometry, and minimum structural complexity.

OTHER ADVANCED CYCLES: Marquardt's research, development, and production activities in airbreathing propulsion have served as basic building blocks for many new and interesting engine cycles. Individually and in combination, these advanced cycles offer exciting propulsion possibilities for launch vehicles and missiles which will allow improved operational capability. Marquardt is currently evaluating these concepts under active contract.

PROFESSIONAL CAREER OPPORTUNITIES: Marquardt is offering long term career opportunities in airbreathing propulsion technology to experienced aerospace engineers and scientists, test facility personnel and technicians. Qualified personnel are invited to submit resumes to Professional Personnel Dept. 135, The Marquardt Corporation, 16555 Saticoy Street, Van Nuys, California, or to Personnel Dept., General Applied Science Laboratories, Inc., Merrick & Stewart Aves., Westbury, New York. Marquardt is an equal opportunity employer.

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NEW CAREERS IN
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SURFACE
MISSILE
SYSTEMS

The Applied Physics Laboratory, The Johns Hopkins University, has undertaken a new and comprehensive Industrial Engineering Program to support Surface Missile Systems engineering for the Navy. Program conformance is directly relevant to operational reliability. Applying to producibility, cost reduction and maintainability as well as reliability, this broad-based IE effort has opened up career opportunities of exceptional potential for senior engineers with at least 10 years experience in:

MECHANICAL ENGINEERING

To perform mechanical engineering design, development and design analysis of missile structures, instrumentation and test, launchers, advanced mechanical and hydraulic components and servo-mechanisms. BSME or MSME, must know applications of manufacturing equipment and processes, should be familiar with design and application of servo systems and components.

ELECTRONIC ENGINEERING

To perform electronic engineering design, development and design analysis of general missile electronic circuitry, autopilots, guidance computers, control servo loops, checkout and test equipment and ship-based search, tracking and guidance radar. BSEE or MSEE, major experience should be in missile guidance and control electronics, and ground-based support and test equipment; thorough knowledge of electronic fabrication processes and techniques required.

ELECTRO-MECHANICAL ENGINEERING

To perform engineering design, development and design analysis in areas of mechanical packaging (of electronic equipment), electro-mechanical devices, coordination of electronic and mechanical interfaces, shock and vibration isolation of electronic equipment, and investigation and evaluation of fabrication processes and techniques. BSME or MSME with electronics minor, missile experience preferable; must be thoroughly familiar with electro-mechanical interfaces and application of mechanical design principles to development, fabrication and packaging of electro-mechanical equipment. Candidates for all positions must be capable of presenting technical data in clear and concise written reports.

Please direct your inquiry to:
Mr. W. S. Kirby, Professional Staffing

The Applied Physics Laboratory
The Johns Hopkins University
8621 Georgia Avenue, Silver Spring, Maryland
(Suburb of Washington, D.C.)

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letters

Changing Course

To the Editor:

I must say that I was startled by your Sept. 6 issue, which includes the special report on oceanography—startled for two reasons: 1) the novelty of your publication addressing itself to such subject matter, and 2) the clarity and comprehensiveness of the coverage.

It is one of the most competent jobs of reporting on marine sciences I have seen, and I guess I shouldn't be surprised that the firms that have been working on the materials and technology needed for space exploration should turn their talents to the field of undersea exploration.

You've done a good job of cataloging the materials under study for deep-diving vehicles, but I'm afraid you've overlooked the important work of Pittsburgh Plate Glass Co. in developing a remarkable submersible made of glass.

Paul Franklin
New York City

More on MOL

To the Editor:

Thank God we've finally committed ourselves to building a *Manned Orbiting Laboratory*. Between our increasing preoccupation with conventional warfare and the growing notion that NASA is the only legitimate contender for space operations, I was despairing of this country's military ever getting a role to play in space.

I don't think it requires a great deal of imagination to appreciate the advantages that will accompany our successful operation of the first *MOL*. The deterrent capability of such a craft is enough justification for its price. Anything we gain beyond that will be a bonus.

Edwin C. Culver
Detroit

ASTROLOG REPRINTS

REPRINTS of the latest edition of the MISSILES AND ROCKETS *Astrolog, which appears in this issue, may be obtained from:*

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tensive Westinghouse capability in is area stems from a solid background contemporary avionics—radar, mmunications, countermeasures, ta processors, and electro/optical stems (including lasers).

In radar systems, this background cludes WW II's APS-5 . . . today's lse radars like the APQ-72, 100, and 109 systems . . . and multi-mode missile control systems such as the Westinghouse AWG-10 in current production for the F-4 aircraft.

The avionics systems teams couple this background with the division's long-term, intimate knowledge of military problems and requirements, and Westinghouse experience in the management of national defense projects.

Information on this Westinghouse avionics activity is available only through proper security channels (upon confirmation of your need-to-know). Write Marketing Manager, Aerospace Div., Westinghouse Defense & Space Center, Box 746, Baltimore 3, Md.

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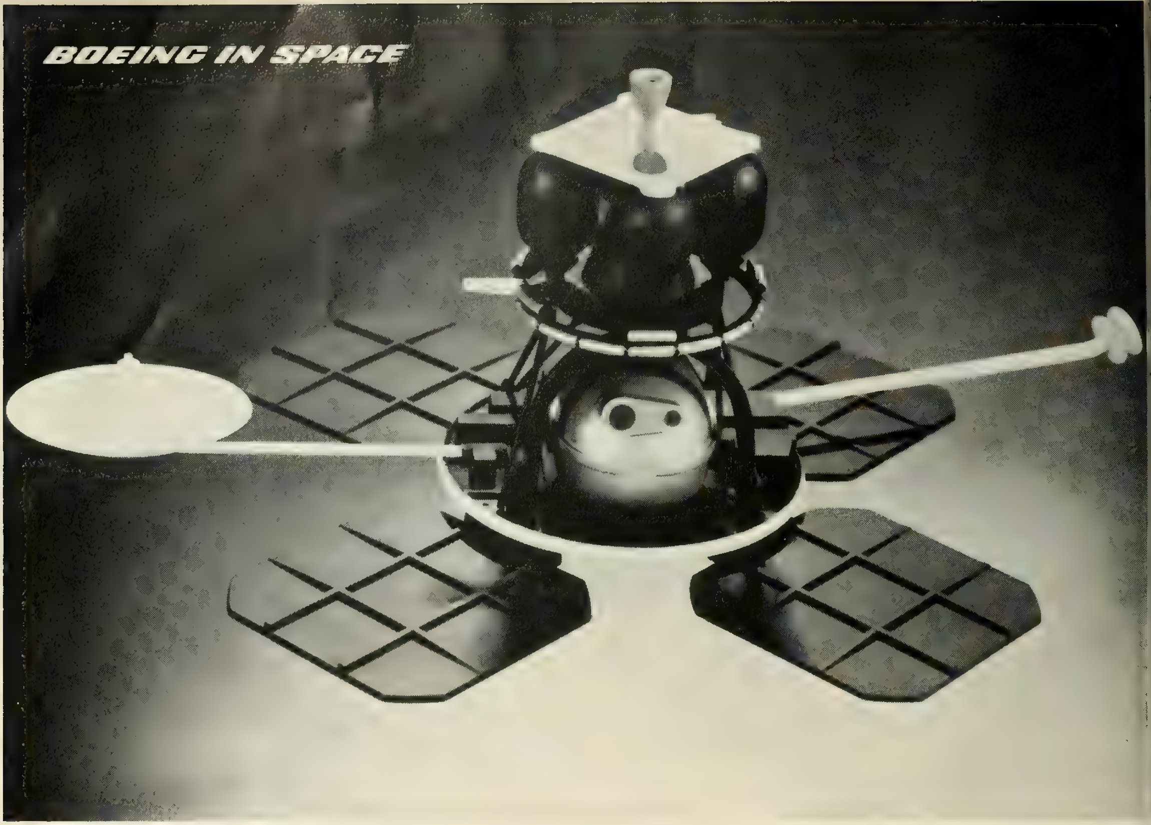
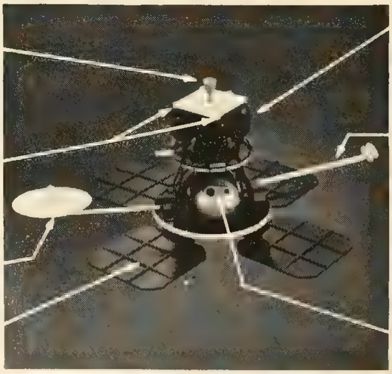


Much must be learned about the moon before America's first manned lunar expedition is launched. Thousands of square miles must be photographically explored to select desirable surface areas for manned lunar landings. Radiation must be measured. To get this information—and more—NASA will launch a series of camera-carrying Lunar Orbiters next year.

Lunar Orbiters will circle the moon, flying within 28 miles of the surface. Each one will take a series of sharp, detailed pictures, convert them into electrical signals and transmit them to earth. On a typical mission, a Lunar Orbiter could photograph the equivalent of a one-mile-wide strip between New York and Los Angeles, clearly showing objects as small as a card table. In addition, Lunar Orbiter will sense and report information on micrometeoroids, solar flares and magnetically trapped particles. As each Orbiter continues to circle, scientists will be able to monitor its orbit to gain more precise knowledge of the moon's mass and gravitational field.

Boeing is building eight Orbiters for National Aeronautics & Space Administration's Langley Research Center, three for special tests, five for flight. **Boeing Space Division.**

Lunar Orbiter



Velocity-control rocket (for midcourse corrections and lunar orbit maneuvers).

Attitude-control thrusters. Eight are located at corners of heat shield.

Three-foot parabolic dish antenna

Solar panel. Four panels will generate 266 watts of electrical power.

Two fuel and two oxidizer tanks.

Omni-directional antenna. Antennas will pop out after Orbiter is in frictionless space.

Camera lenses. Photographic subsystem includes 70-mm. film camera, processor, electronic readout system.

The Countdown

WASHINGTON

MOL: Open or Closed Door?

First test of security policy on the *Manned Orbiting Laboratory* program will come next month when Gen. Bernard Schriever delivers a talk on the subject at the American Institute of Aeronautics and Astronautics meeting on Manned Space Flight in St. Louis. There has been some talk at the Pentagon of dropping a *SAMOS*-like security curtain around *MOL*, but Air Force is arguing against this.

Least Surprising News of the Week

The Soviet Union's rejection of President Johnson's invitation to view the launching of the *Gemini 6* mission came as a surprise to no one. Although the White House did not suggest it, the Soviets view such arrangements as reciprocal and they are not yet ready to throw open their launch pads to Western eyes.

Big Solid Beats Betsy

The smashing passage of Hurricane Betsy through South Florida had little or no effect on Aerojet-General's 260-in. solid motor at the firm's Dade County, Fla., facility. The nozzle had been attached to the massive rocket and the facility battened down prior to Betsy's onslaught. The Aerojet installation was built with such events in mind. Company spokesmen say there will be no delay in the demonstration firing now set for the last week in September.

Modular Cryogenic Engine RFP's Due Soon

Air Force is preparing proposal requests on a new liquid hydrogen-LOX modular rocket engine for release in the near future. The program is an advanced development item revealed by Dr. Harold Brown during recent Senate hearings. The program will be managed by the Rocket Propulsion Lab., Edwards Air Force Base, a unit of the Research and Technology Div. of the Air Force Systems Command. The powerplants will generate about 250,000 lbs. thrust using high-pressure combustion chambers and advanced nozzle concepts. NASA will provide complementary support.

Schriever To Wear Two Hats

Gen. Bernard A. Schriever will remain commander of the Air Force Systems Command in addition to his duties as manager of the *Manned Orbiting Laboratory* program office. As *MOL* manager, the AFSC chief will report directly to new Secretary of the Air Force Dr. Harold Brown.

Smile When They Go Over

Gemini 6 pilots Walter M. Schirra and Thomas P. Stafford will carry a 6-in. hand-held telescope with 10× zoom power magnification aboard their spacecraft, Manned Spacecraft Center has revealed. Six telescopes equipped with reticles for enlarging the field of view have been purchased by MSC from Aerospace Controls Corp. of Los Angeles for $22,455. An MSC spokesman said the instruments are not associated with any of the approved *Gemini* experiments but are strictly for viewing objects of "pilot preference" from orbital altitudes.

INDUSTRY

Douglas Gets Award from Comsat Corp.

Communications Satellite Corp. plans to award a $45,000 contract to Douglas Aircraft Co. for a launch trajectory simulation program. The computer system will provide engineering analysis and evaluation of various booster capabilities. Delivery will be within five months. The proposed contract has been submitted to the Federal Communications Commission for approval.

TI Doubles Integrated Circuit Speeds

Doubling of integrated circuit speeds is achieved by Texas Instruments' new patterned epitaxial technology when it is applied to logic circuits made by the dielectric isolation technique. Saturated logic circuits with speeds in the 1.5-nanosecond range have been produced using the process. TI has also announced its selection of molybdenum as an intermediate layer in gold-aluminum ball bonds to overcome thermal degradation problems encountered in integrated circuits.

New Test Set for Launch Escape System

North American Aviation's first production *Apollo* spacecraft (002) will be lifted from White Sands Missile Range Pad 36 later this year in another test of the Launch Escape System (LES). The *Little Joe II* launch vehicle will be programmed to simulate a tumble in power-on mode at 58,000 ft., triggering the LES solid rocket motors into separating the Command Module from the disintegrating booster and carrying it to an altitude of 78,000 ft. The test is designed to study plume impingement on the spacecraft.

Big Chunk for Small Business

Small business firms received $5.3 billion in prime contract awards from the Department of Defense in Fiscal Year 1965, an increase of $463 million over FY 1964. This is the highest dollar volume since 1952. The percentage of small business dollars has risen to 20.3% from 18% in FY 1964, according to Deputy Assistant Secretary of Defense John M. Malloy.

INTERNATIONAL

Second Europa Test Hits Trouble

Second static test of the European *Europa-I* satellite launching vehicle was cut short last week during static test firing of the Rolls-Royce RZ-2 rocket engines at Spadeadam Waste in Cumberland, England. Site instrumentation apparently interrupted the firing after the first few seconds of a scheduled 140 sec. run. A similar shut-down occurred during the first static test Aug. 3. The vehicle was a half-live, half-dummy configuration made up of a live *Blue Streak* first stage with dummy second and third stages.

Smaller, more accurate, more flexible Univac digital computers adapt to a wide variety of aerospace applications.

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The Missile/Space Week

First Apollo Due at Cape

The first unmanned *Apollo* spacecraft (009) will be delivered to Cape Kennedy in two weeks for use in an unmanned re-entry ballistic mission, scheduled for "the first quarter of 1966."

The spacecraft will be launched by a *Saturn IB*, accelerated downward after reaching the peak of its trajectory, and rammed back through the atmosphere to qualify the heat shield under a moderately high-speed reentry. The additional 3,000 fps to increase re-entry speed from 26,000 to 29,000 fps will be provided by burning the Service Module's engine for about 200 secs., a Manned Spacecraft Center official said.

The Command Module will reenter at a steep angle (9 degrees) to encounter high heating rates. At the same time, a high heating load will be imposed on the shield through a maximum-lift angle-of-attack. The spacecraft will extend its horizontal motion in relation to the Earth's surface, rise slightly until velocity dissipates, then "step" downward to continue on a ballistic trajectory.

Re-entry is considered to begin at 400,000 ft. with most of the heating occurring in the region between 270,000 and 200,000 ft. Splashdown is expected 4,000 n. mi. downrange near Ascension Island.

Douglas Leaves SRAM Contest

Douglas Aircraft Co. has pulled out of the prime contractor competition for the Air Force's *Short Range Attack Missile.* The move leaves only the Martin Co. and Boeing bidding for the program.

Douglas explained that its heavy involvement in other programs, most notably the *Manned Orbiting Laboratory,* was responsible for its decision to withdraw.

Talos Low Bidders Announced

Sperry Utah and Bendix Corp. have been identified as low bidders for production of the Navy's *Talos* surface-to-air missile. Award of the contract is expected soon.

The low-bidder announcement was made at a recent "public opening" held on an invitation to bid on some $37 million worth of business in the program.

Bendix submitted the low bid on the 3-year option, and is thought to have an edge as a result. The Navy is felt to favor a 3-year program.

The IFB is said to call for the production of some 470 missiles at a cost in the neighborhood of $80,000 per unit. Under the 3-year buy option, Bendix was said to have submitted a bid having a unit cost of $80,356 and Sperry a unit cost of $80,875. Sperry was said to have been the low bidder under both the 5- and 1-year options. Bendix Mishawaka was the original contractor for the missile.

Unit cost under the original contract was said to be in the area of $120,000, with one report having the unit cost about $132,000.

The IFB is said to concern the normal production of the *Talos* missile. No relationship is seen with the reported demise of the *Advanced Surface Missile System* (*ASMS*) program, nor with the state of the standard missile and the "get-well" program for the *Tartar*, *Terrier*, and *Talos* missiles. No *Talos* improvements are anticipated in the production contract.

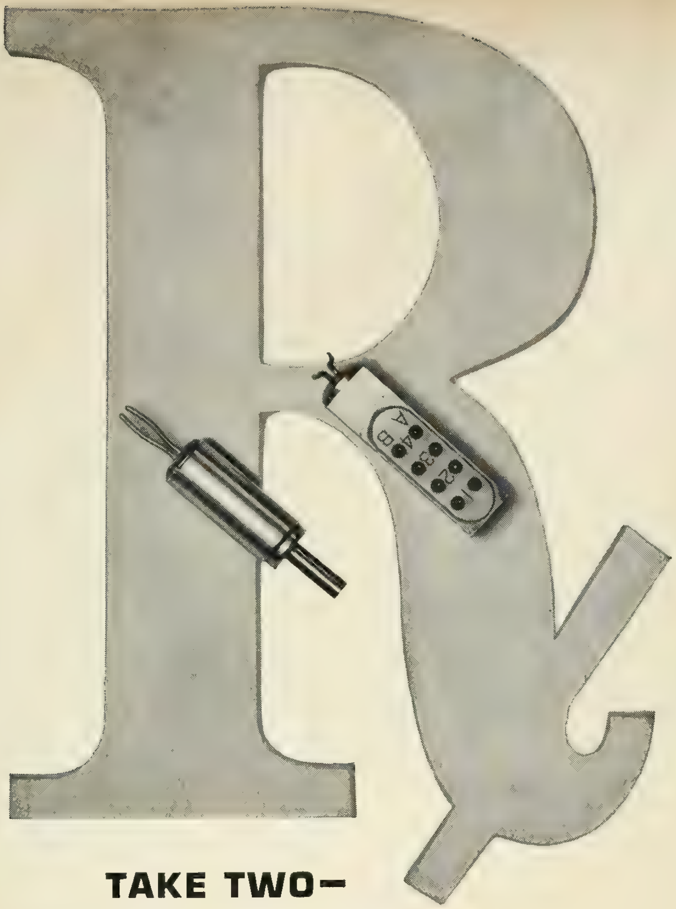
According to reports, the Navy held its bidders' conference for the proposed multi-year buy of *Talos* on April 6-7, and then sent out the bid package ahead of the April 30 target date. Among the companies receiving bids were: Bendix Mishawaka, Boeing, Chrysler, Douglas, Fairchild Hiller, General Dynamics/Pomona, Goodyear, Honeywell, Hughes, LTV Aeronautics, Lockheed Missiles & Space, Martin/Orlando, Maxson, McDonnell, North American Aviation/Columbus, Northrop/Ventura, Raytheon, Sperry and Texas Instruments.

Comsat RFP's Issued

Communications Satellite Corp. has issued RFP's to 29 firms for communications and control equipment for use at two satellite ground stations to be constructed in Hawaii and Washington.

The request covers design, fabrication, assembly, delivery, installation, testing and checkout of the equipment. Two sets of ground communications equipment with one control unit will be integrated with two antenna systems in both stations, Comsat said. Deadline for proposals is Sept. 30.

Meanwhile, RCA Communications, Inc., asked the Federal Communications Commission for permission to acquire an ownership and operating interest in the new stations and in the ground station at



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Andover, Me., currently being leased by Comsat. Negotiations are in progress for Comsat's purchase of the station from American Telephone & Telegraph Co.

Wheeler on 'Overmanagement'

Defense planners must constantly guard against "overmanagement and overcontrol" within the Dept. of Defense, according to Gen. Earle G. Wheeler, chairman of the Joint Chiefs of Staff.

To do this, there must be a precise differentiation between the roles of the commander and the manager, Gen. Wheeler told a Sept. 2 meeting of the Armed Forces Management Assn. "A commander is responsible for military success or lack of it, and the manager is responsible to provide maximum efficient support to the commander, not to try to manage him," he said.

Armed forces operations in the past have been successful because commanders have not had their hands tied by management directives "woven by theorists at higher headquarters," Wheeler told the meeting.

Most important, said Wheeler, "the manager must remember just what kind of support he is expected to give the commander—quality equipment and personnel, delivered on time to permit accomplishment of the mission concerned."

New Paraglider Tests Begun

NASA is running a new series of manned paraglider tests for possible application to the *Apollo* program.

The series—last run in December, 1964—uses a *Gemini* boilerplate spacecraft to gather quantitative aerodynamic data, develop navigational techniques and develop operational procedures for handling a variety of wind conditions.

First manned test was made by North American Aviation test pilot Donald F. McCusker. During tests, the vehicle is towed to an 8,000-ft.-altitude by a helicopter and released, with the pilot gliding back to the landing point.

The paraglider, originally conceived for use in Project *Gemini*, is being continued as an operational research project.

Stanford Gets NASA Funds

Stanford University has received a $2.08-million NASA facilities grant as partial funding for a new space engineering building to be built in the school's science quadrangle.

The grant covers the cost of constructing 65,000 sq. ft. of a planned 105,000-sq.-ft. structure to be used for multidisciplinary research and training programs.

The school has been involved in NASA-sponsored programs since 1959, and currently holds more than 40 NASA grants and contracts worth some $9 million. The new building will provide facilities for 17 active programs, including radar, radio astronomy, astrophysics, planetary magnetospheres, re-entry physics, ionospheric phenomena, structures, mechanics, fluid dynamics, propulsion and other space related studies.

Shots of the Week

NASA on Sept. 1 used a *Nike-Apache* vehicle to launch a payload to measure electron and ion densities, to record temperatures and to compare the operation and performance of five different types of ionospheric plasma probes. The experiment was conducted by the Southwest Center for Advanced Studies, Dallas, and by the Central Radio Propagation Laboratory of the National Bureau of Standards. The 80-lb. payload reached a maximum altitude of 94 mi. and impacted 74 mi. downrange in the Atlantic.

Army Keeps Eyes on Horizon

Defense planning by the Army against enemy attacks at low altitudes is based largely on a prediction that such attacks during the next 10 years will occur during fair weather.

The estimate is based on the contingency that no breakthrough occurs in the development of radar that would enable the enemy to drastically improve its all-weather attack capability.

According to an informed Pentagon source, the all-weather capability of the enemy in low-flying aircraft anticipated 7 or 8 years ago has not materialized.

The Russians will have a degree of all-weather, low-level attack capability within the next decade and the *Hawk* and *Nike-Hercules* systems have been designed to meet this threat.

LTV Official Killed in Fall

Col. Gene G. Surdyk, Ling-Temco-Vought's Washington public relations representative since June 1, died Sept. 2 at Ft. Hood, Tex., Army Hospital of injuries received in a fall from a horse.

LUNAR HOSTILITY • MANNED SPACE FLIGHT • ROCKETRY • UNMANNED FLIGHT • MICROMETEOROIDS • MAN-MACHINE SYSTEMS • GUIDANCE • TRAJECTORY • ALTERNATE EARTH RETURN • COMMUNICATIONS • NAVIGATION • CELESTIAL MECHANICS • COMPUTING • SIMULATION • RE-ENTRY • LUNAR LAUNCH • PROGRAMS • STATISTICS • SYSTEMS OPERATIONS • SPACE VEHICLES • PROPULSION • SOLAR RADIATION • APOLLO CHECKOUT • TELEMETRY • HEAT TRANSFER • EVALUATING • LOGIC • OPTIMUM ABORT PROCEDURES • RELIABILITY • PROBABILITY • VEHICLE DYNAMICS • SERVOMECHANISMS • DESIGN • BALLISTIC FLIGHT • AUTOMATIC DIGITAL CONTROL • PAYLOAD CAPABILITY • GEOPHYSICAL TECHNIQUES • AUTOMATIC TROUBLE DIAGNOSIS • DATA PROCESSING

WANTED: SPECIALISTS IN SPACE

Above are some of the divisional functions of Bellcomm, the systems engineering contractor of the National Aeronautics and Space Administration. Bellcomm is utilizing a wide range of disciplines in its extensive feasibility studies and operations analysis of manned space flight systems.

Bellcomm's work on Project Apollo offers rewarding employment opportunities for persons especially qualified in such fields as physics, mathematics, computing and programming, engineering, flight mechanics, chemistry, propulsion, guidance and trajectory analysis.

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DDR&E Changes Dilute Space Role

Separate deputy directorship held by Hall to be combined with strategic systems under Fink; Rogers gets new post

by Heather M. David

HALL

FINK

ROGERS

THE DIRECTORATE of Defense Research and Engineering has undergone a major realignment with the elimination of a separate deputy directorate for space and the creation of a new directorate for electronics and information systems.

Dr. Albert C. Hall, former deputy director for space, returns to the Martin Co. in his former capacity as vice president after a little more than two years at DDR&E. Nominated for the new post of deputy director for electronics and information systems is Thomas F. Rogers, former assistant director (communications and electronics) in the research and technology deputy directorate.

No word has yet emerged as to the name of a successor to Dr. Harold Brown as Director of Defense Research and Engineering. However, the shuffling of offices and the elimination of a separate space activity has led to speculation that DDR&E's influence will be downgraded with Dr. Brown as Secretary of the Air Force, and with Gen. Bernard Schriever directing the *Manned Orbiting Laboratory* program and reporting directly to Dr. Brown.

The official memorandum concerning the new assignments stated only that "the reorganization is needed to obtain a better balance of personnel and workload requirements and to improve the coordination and monitorship of certain systems/programs/activities."

• **Strategic and space**—All elements of the former space directorate under Dr. Hall become the responsibility of the director of strategic and defensive systems, Daniel J. Fink, who takes the title of director of strategic and space systems. Elements of the former space group move under his aegis, so that assistant directors reporting to Fink will include those for strategic weapons, defensive systems, space technology, and ranges and space ground support.

• **Electronics and information**—The program element of command and control that was formerly under the strategic and defensive systems director becomes the task of the new director of electronics and information systems. Rogers is to be acting deputy director pending approval of his nomination.

Officials who will report to him are the assistant directors for communications and electronics, command and control, and intelligence and reconnaissance. The latter will also serve in some respects in his former position of special assistant to the head of DDR&E.

Dr. James Bridges, special assistant for command and control, will be a special assistant to the electronics and information systems group.

• **Tactical warfare**—Names of some of the elements have been slightly changed. Now reporting to the deputy director of tactical warfare programs are assistant directors for tactical aircraft systems, tactical missiles and ordnance, tactical control and surveillance systems, and sea warfare systems. A tactical systems review and analysis office will also be established in this group.

• **Research and technology**—Assistant directors in this group will be for research, materials, chemical technology, and laboratory management, the latter being a new post.

• **Administration and management**—This unit, headed by Lt. Gen. William J. Ely (USA) remains essentially unchanged.

Other elements of DDR&E also remaining the same are the positions of assistant directors of international programs, special intelligence, and nuclear programs. The functions and personnel of the Advanced Research Projects Agency (ARPA) and the Weapons Systems Evaluation Group (WSEG) are unaffected by the reorganization.

The moves are not expected to be completed until Sept. 20. Several projects will be transferred along with personnel, and physical working space in DDR&E's quarters reassigned.

One position downgrading recently in DDR&E came with the removal of the title of assistant secretary of defense from the post of the chief assistant or deputy to the Direcor of Defense Research and Engineering. At the time, it was disclosed that a new post would be created—the Office of System Analysis—at the DOD level. Alain C. Enthoven was named to this post. No successor to Dr. Eugene Fubini, former deputy to Brown, has been named.

• **Fink's background**—The transfer of several programs to Fink would appear to increase his voice in the missile/space field considerably. Fink was promoted to the post of deputy director for strategic and defensive systems May 1, having been assistant director for defensive systems.

Before his association with DOD, which began in August, 1963, Fink was vice-president of Allied Research Associates, Inc. of Concord, Mass., responsible for management of all technical operations of the company. He was previously chief of aircraft dynamics at Bell Aircraft Corp., and was employed by Cornell Aeronautical Laboratory. He holds B.S. and M.S. degrees in aeronautical engineering from Massachusetts Institute of Technology.

The function of DDR&E is to act as advisor to the Secretary of Defense in the fields of scientific and technical matters, basic and applied research, research, development, test and evaluation of weapons, and weapons systems and defense materiel. The director is appointed by the President with the advice and consent of the Senate.

The post had an unprecedented influence under Dr. Brown in controlling the research and development complex of the armed forces. ■

Scramjet Flights May Begin in 1967

Program initiated by award of $5-million contract to team composed of Marquardt, GASL and Lockheed-California Co.

by Willard E. Wilks

THE AIR FORCE will undertake a program to evaluate supersonic combustion ramjet (Scramjet) propulsion under actual flight conditions in launches with a solid booster at the Western Test Range, Vandenberg AFB, probably starting in 1967.

The program has been initiated with award of a $5-million contract to Marquardt Corp., Van Nuys, Calif., which has teamed with General Applied Science Laboratories (GASL) and Lockheed-California Co. Lockheed will provide pre-flight assembly and check-out with its Vandenberg facility.

The flight vehicle will represent the first application of the modular engine approach to Scramjet, with four modular engines mounted around the vehicle, approximately 3 ft. in diameter and more than 10 ft. long. The vehicle contains a hydrogen fuel tank and instrumentation.

Ground launch will be used to permit closer control of end booster conditions, low cost and growth potential.

The vehicle will be launched with an *Athena*-like booster, a single-stage Castor solid-propellant rocket. Initially, the Scramjet vehicle, following separation from the booster, will demonstrate operation at speeds in excess of Mach 5 at altitudes running far above 50,000 ft.

MARQUARDT artist's concept of Scramjet flight test vehicle.

- **Modular approach**—In the Scramjet concept developed by Marquardt, the body surface of the vehicle serves as part of the engine itself, the sharp, conical nose fairing providing part of the inlet leading to the jet scoop, and the afterbody surface being integrated with the exit. Thus in the modular concept, although the engines are closely integrated with the vehicle body, they are nevertheless separable from specific sizing and structural considerations, permitting development of a single engine that can be used on a variety of vehicles, as well as use of the original flight test vehicle with other engines.

In addition, it is believed the modular concept provides both flexibility and savings in size and cost of ground tests and facilities, items that could weigh in favor of retaining the modular design in future operational systems. It is also believed the vehicle to be developed for the evaluation program may well prove to be useful in other test programs.

In the test vehicle, a simple fuel-metering control will provide fuel flow matching the trajectory requirements. The vehicle will accelerate on its own thrust in the initial portion of the flight. Mach number reached will be limited by quantity of fuel. Fuels other than hydrogen are also under investigation.

A non-burning flight test will check the vehicle stability, booster trajectory tolerances, telemetry equipment and separation devices, whereupon final flight engine design will be established. Marquardt will conduct a complete system ground test, and each complete Scramjet flight vehicle will be given an acceptance test before flight. Initial phases of the flight test program consist of three separate flight tests using identical hardware.

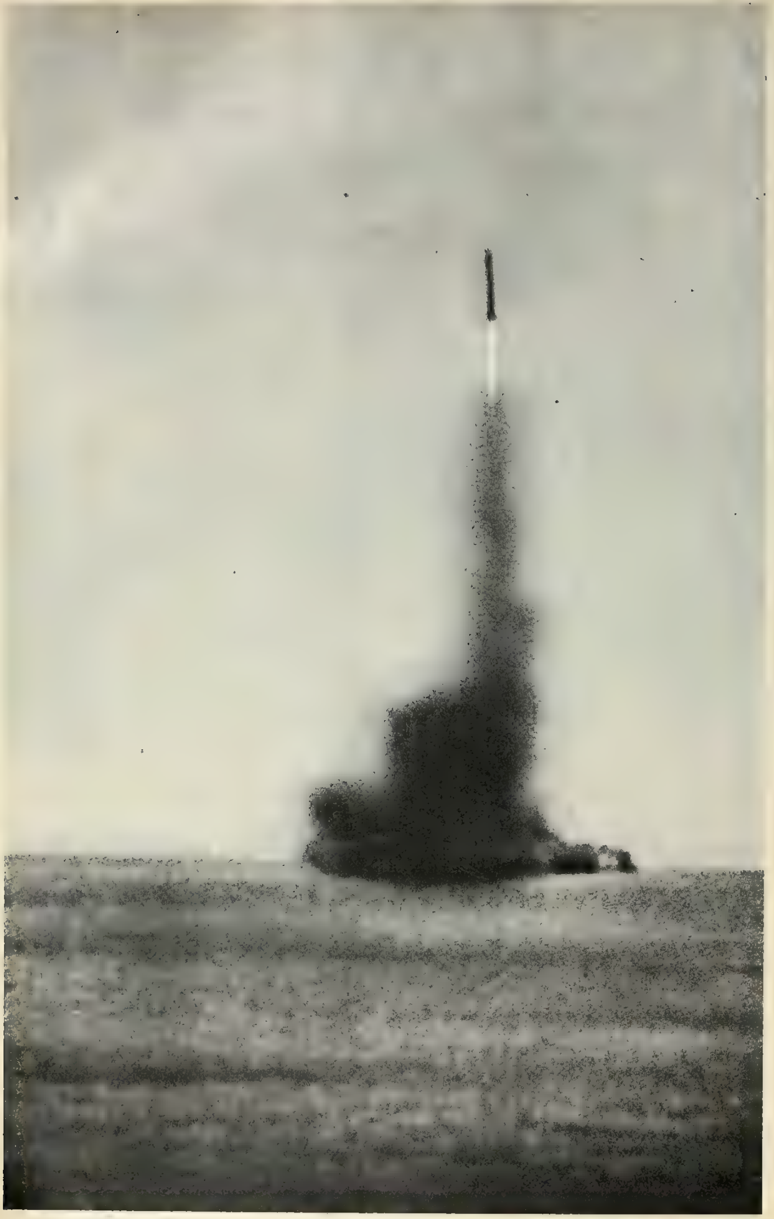
In addition to data telemetered from the vehicle, ground tracking radars will determine flight trajectory and check the velocity and acceleration history of the vehicle under Scramjet power.

- **Engine function**—The modular Scramjet engine inlets operate in the pressure field of the vehicle forebody. The inlet diffuser provides static pressure and temperature at the burner entrance for rapid combustion reactions of the hydrogen-air mixture. After combustion, the gases are accelerated through a divergent exit nozzle section and further expansion effect is obtained on the aft body of the vehicle. Static and dynamic stability is achieved by tail fins mounted at the aft end of the body. The forward section of the central body houses a telemetry package that relays the pressures and temperatures measured on internal surfaces of the propulsion system.

Both ground- and flight-test data will be correlated to insure high confidence in the ability to analytically predict in-flight performance. This is seen as a key step by the Air Force Aero Propulsion Laboratory in establishing the practicality of Scramjet propulsion for future missiles and manned aircraft. Evaluation of the validity of various ground test techniques in simulating the actual flight environment and developing in-flight instrumentation methods for accurate assessment of engine performance and operation are prime objectives in the test program.

Although the initial Scramjet flight-test program will explore a limited velocity range, substantial growth potential is available in the flight-test approach.

Air Force spokesmen believe the concept is attractive for air-to-air and air-to-ground missiles. It is believed possible it could find application in a *SRAM*-type weapon. Other projected applications include propulsion for interceptor missiles and trajectory control for extremely-high-acceleration solid-rocket intercept missiles in which trajectory control would be impossible by ordinary means. ■



ABOVE (1): Launch of submerged ballistic missile.

BELOW (2): Opening to silo for Soviet strategic missile.

Air Defense Featured in Soviet Film On Missiles

PHOTOS published recently in the Soviet consumer magazine *Ogonyok* reflect the emphasis in the USSR on anti-missile missile development.

One weapon (photo 7) appears to be strikingly similar to the U.S. Army's *Sprint*—part of the *Nike-X* anti-missile system. The photos appeared in the June issue in an article written by Col. V. Datsenko, Col. of Engineers M. Mryakin and Capt. First Class N. Izmailov.

The article's authors say their air defenses "are capable of bringing down every type of missile a potential aggressor has."

An editor's note accompanying the article explains that the photos are taken from a documentary film "20th Anniversary of the Great Exploit." The film was to be shown in Russian theaters to demonstrate in action the weapons seen on parade in Moscow's Red Square (M/R, May 17, p. 16) last May 9—the 20th anniversary of the end of World War II in Europe.

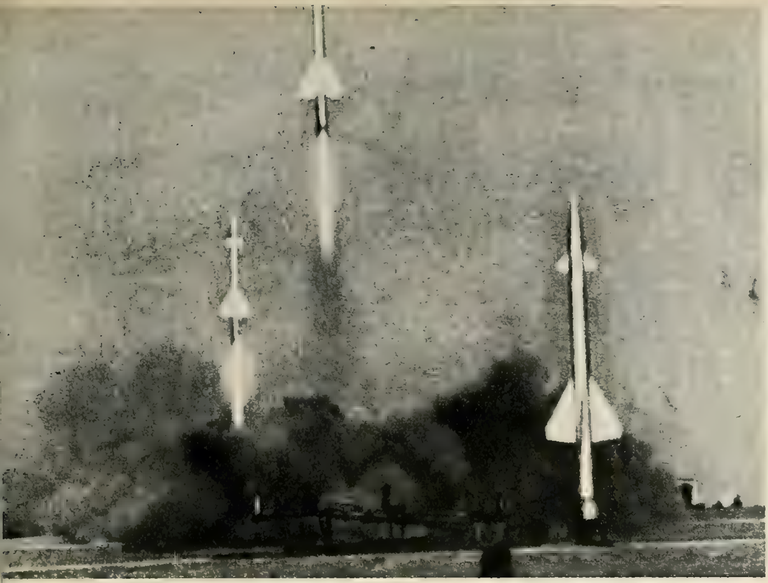
Photo 1 is said to depict a submerged firing "to give an idea of the launching of a ballistic missile from the ocean's depths."

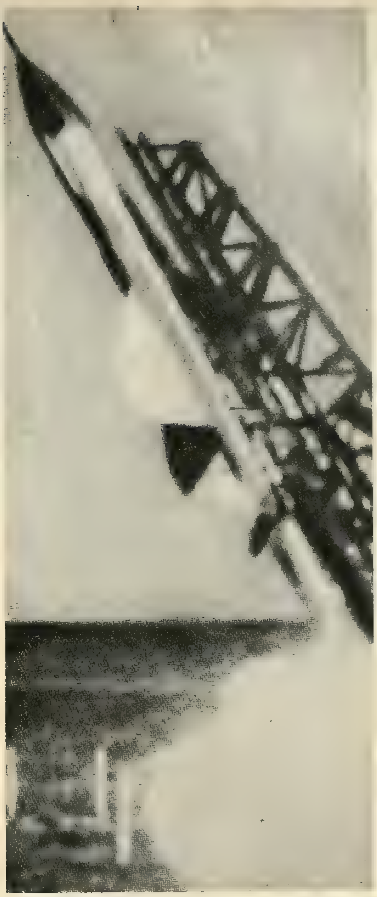
Photo 2 is described as an underground silo for a strategic missile, which is "carefully concealed from air and space reconnaissance."

Photo 3 is reported as a salvo launching of anti-aircraft missiles for the simultaneous destruction of radio-controlled aircraft drones, and photo 4 is said to show the destruction of airplane targets by nuclear explosion. The editor's note points out that the nuclear detonations were photographed before 1963. The nuclear test ban treaty was ratified by the U.S. Senate Sept. 24, 1963.

The Soviet magazine article describes photo 5 as being the intercepted warhead of a ballistic missile that had been flying at "cosmic velocity," and photo 6 is said to be the launch of a long-distance anti-missile missile of a type that intercepted such warheads "with a high degree of accuracy."

Photo 7 reportedly shows the launch of the *Sprint*-like "more effective anti-missile missile." ■





ABOVE LEFT (3): *Anti-aircraft missiles.*

ABOVE RIGHT (6): *Anti-missile missile launch.*

CENTER LEFT (4): *Nuclear fireball destroys aircraft.*

LEFT (5): *Intercepted missile warhead.*

RIGHT (7): *Sprint-like A-ICBM takes off.*

Agena Re-Use in Orbit Considered

GT-6 target vehicle may be left in space to rendezvous again on later flight; docking flexure concerns planners

by Jinx Mercer

HOUSTON—The *Agena* rendezvous vehicle may be kicked into a 250-300 n. mi. circular orbit after completion of the *Gemini 6* mission to re-rendezvous with the *Gemini 7* two months later, or to serve as a "backup" *Agena* for *Gemini 8.*

However, major orbital maneuvers with the spacecraft attached and using the 5,500 fps Δv capability of the *Agena* primary propulsion system (PPS) must await the second *Agena* sent into space, according to Jerome B. Hammack of the *Gemini* Program Office here.

Of some concern to planners is the possibility of flexure or bending problems introduced by the dynamic interaction of the two vehicles in docked configuration, he said. Navy Capt. Walter M. Schirra and USAF Maj. Thomas P. Stafford will determine the extent of flexing through operational checks to be performed during the *Gemini 6* mission. They will accelerate the target vehicle using spacecraft thrusters and attempt to make pitch and yaw attitude changes.

Docked, the *Gemini/Agena* combination will be controlled by the *Agena* cold-gas attitude-control system. Instability resulting from flexure at the mechanical coupling of the mated vehicles will be circumvented, according to Hammack, by retarding thruster responses to attitude-control inputs. This was done by adding an electrical feedback loop in the circuitry to restrict the initial jet action. Hammack said this has the effect of damping abrupt attitude changes that might create the undesirable bending moments.

"We want to make sure the dynamic interaction of the two vehicles is satisfactory before we burn the *Agena* engine (with the spacecraft attached) for the first time," he said.

● **GT-8 maneuvering**—The first major orbital change accomplished by the two vehicles during *Gemini 8* will probably be a plane change rather than an altitude change to stay within the safe heating limits of the spacecraft heat shield should re-entry become necessary from the higher altitude. The extent of translational maneuvering will affect recovery and post-maneuver tracking.

Orbital injection and major orbital changes will be made by the *Agena* primary propulsion system, which develops 16,000 lbs. of thrust for 240 sec. The engine burns unsymmetrical dimethyl hydrazine (UDMH) as fuel and inhibited red fuming nitric acid as oxidizer. Vernier corrections will be made using a secondary propulsion system.

The target vehicle will be stabilized "at all times," Hammack said. Life expectancy of the vehicle is estimated to be about five days. Stabilization will be in one of two deadbands—plus-or-minus one degree in all axes for fine attitude hold, or plus-or-minus five degrees in all axes for coarse attitude hold.

The vehicle carries approximately 140 lbs. of control gas—a mixture of freon and nitrogen—in three 2,200-cu.-in. spheres pressurized to about 3,000 psi. Usage will vary from 35 lbs. to 0.005 lbs. per hour, depending upon the control mode.

Modifications to the six *Agena* target vehicles purchased from the Air Force Systems Command by NASA for $68,630,000 include the addition of a status panel and a V-notched docking collar. The panel displays instantly the safe or unsafe condition of the vehicle for docking by the appropriate green or red light.

Other lighted indicators give the status of the electrical power system, burn times remaining on the primary and secondary propulsion systems, and amount of attitude gas remaining.

● **Docking procedure**—Once the spacecraft moves into the docking collar, lights will indicate when the vehicles are rigidized and when the spacecraft is under control of the *Agena* system.

Astronauts will move the spacecraft into the docking collar of the vehicle by aligning an index bar on the small end of the spacecraft with the V-notch of the docking collar. Impact will be attenuated by hydraulic damper assemblies. As the nose slides into the collar, three latches will seat themselves against the spacecraft automatically, actuating mooring drive motors that will retract the collar to rigidize the two vehicles and to establish a hardline connection.

Spurious signals that could command the vehicle inadvertently before orbital insertion are not likely to occur, he said. "When it takes off, it will be loaded with zeros." The commands will be sent to the vehicle from ground stations while it is in orbit.

Radio frequency interference (RFI) tests just completed on the two vehicles at Merritt Island, Fla., revealed no significant problems, Hammack said. Tests were conducted on a timber tower and consisted of sending a "baseline run" of about 50 functional commands from the spacecraft to the *Agena* through the hardline connection.

"We unplugged the interface line and used a T-connection to play the signals out on a ground scope," he explained. The signal characteristics of each command were studied. "One of the things we had to determine was whether an anomaly, when it occurred, was a true anomaly or created in the test."

The five-day exercises ended with a simulation of the docking portion of the mission. The *Gemini 6* crew initiated commands from the spacecraft, and the Cape Kennedy mission control center monitored the "flight" for a total interaction of telemetry and communications links. ■

Lunar 'Wheel' Tested

DYNAMIC testing of 12-in.-dia. models of Goodyear's lunar surface wheel-tire is done on suspended test rack. Tire rotates freely in rack and is pressed against a belt moving at 7 mph. Tires are tested to failure.

Technical Countdown

ELECTRONICS

Metal Plasma Tube Solves Laser Ills

Through the use of newly developed gas plasma tubes, marked improvement in the life of continuous-beam gas lasers can be expected, according to Dr. J. D. Rigden of the Perkin-Elmer Corp. Confinement of the gas plasma by means of cooled, stacked, metal discs which replace the more conventional quartz or ceramic tube can permit longer operation of gas lasers at current densities of up to 1,000 amp/sq. cm and at power levels (outputs) about 100 w. So far, P-E developed argon lasers using 19-in. long plasma columns have produced outputs to 9 w. The stacked disc assembly has minimized two principal damage problems associated with quartz tubes: wall erosion due to spluttering and localized damage due to an incandescent spot phenomenon (the latter believed caused by silicon-arc discharge).

Two-quantum Stimulation Process Achieved

Two-quantum stimulated emission, achieved recently by a scientist at the IBM T. J. Watson Research Center, Yorktown Heights, N.Y., may prove to be a suitable technique for obtaining variable frequency, high-intensity laser pulses In a research effort supported by the Army's Electronics Command at Fort Monmouth, N.J., Dr. N. S. Shiren observed such an effect (believed to be the first time) in a maser designed to amplify ultrasonic signals. For the effect to occur, he said, two signals must be present such that their sum equals a characteristic transition frequency of the excited atoms in the generating device. Thus, stimulated emission occurs at both frequencies and two signals can be amplified.

PROPULSION

Porous Hybrid Patents Granted

Two patents covering the concept and structural design of a hybrid rocket using a porous fuel grain were issued to Dr. George S. Sutherland, president of Rocket Research Corp. The grain involved is formed by sintering metal powder —eliminating the need for a hydrocarbon binder. Rocket Research scientists have established that maximum performance is achieved in metallized propellants by minimizing the hydrocarbon binder. In the Sutherland hybrid, the oxidizer liquid passes through the sintered metal grain to the reaction surface. Combustion occurs at the grain surface where there is an intimate mixture of metal fuel particles and oxidizing fluid, both flowing in the same direction. The pre-formed hybrid grain can be adapted to RRC's patented $Be\text{-}O_2\text{-}H_2$ tripropellant system to reach maximum performance without transporting the powdered metal fuel into the combustion chamber. The porous hybrid is throttleable by adjusting the oxidizer flow rate. Ablative chambers or other chamber cooling methods are not needed.

Full-Scale Hot Gas TVC Passes Test

A full-size hot gas valve system for the directional control of large solid rocket motors has repeatedly cycled supersonic 6,000° F. gas flows between two nozzles for 120 seconds exactly according to plan. The valve, a development of Lockheed Propulsion Co., ducts reaction gases from the combustion chamber of a solid rocket into the exhaust flow through the expansion cone of a launch vehicle. A full-scale test of two such valves is scheduled soon using Lockheed's 156-in. diameter segmented motor. The valve itself is built by the Electromechanical Div. of TRW, Inc. The valve work is being funded by the Air Force Propulsion Lab and is part of a broad program geared to develop efficient steering systems for large solid boosters.

MATERIALS

Cholesterol Makes It in Testing

A liquid crystal mixture developed from derivatives of cholesterol by Boeing Co. scientists is being used with complete success in the non-destructive testing of metal parts. The liquid-crystal mixture is painted on the metal component which is then surface-warmed and cooled to 86° F. The surface immediately blossoms into color and any latent defects show up as color differences. Perfect parts cool consistently while flaws cool faster or slower and reveal themselves through contrasting color spots. The liquid crystal mixture reflects light from the surface of the specimen in a series of planes. These planes change their spacing instantaneously as the temperature of the part rises and falls in fractions of degrees. Reversing the technique detects poor thermal insulation. Boeing experts have proven the method on rivet coatings, aluminum, titanium and columbium honeycomb sandwich combinations. Faulty connections in multilayer circuit boards can also be detected. Multi-colored information display systems is a distinct possibility.

Aerojet in Joint Research With NBS

A specialist in low-temperature liquids, on loan from Aerojet-General Corp., is working with a research team at the National Bureau of Standards laboratories in Boulder, Colo. The NBS team, under B. W. Birmingham, has been studying the fundamental properties of low-temperature fluids for several years. The Aerojet scientist, Dale Nielsen, adds to the team's ability to relate new findings to methods for reducing the weight and power required by low-temperature pumps. The NBS Research Associate program brings scientists and engineers from industry to NBS under sponsorship of their own firms. NBS makes the results of such research programs available to all at the end of each project. The Aerojet-NBS project is part of a new emphasis on joint research geared to long-term benefits in science and industry.

GE Doubles RTV Silicone Rubber Strength

Utilization of more efficient polymer linkages has permitted General Electric specialists at the Silicone Products Dept. to come up with an RTV rubber compound with better than twice the strength of current materials. Identified as RTV-630, the new silicone withstands greatly increased pressures at high temperatures. Its tear resistance is equal to heat-cured silicone rubber stock. The compound is an addition-cured room-temperature-vulcanizing liquid silicone rubber. The major markets predicted for RTV-630 by GE spokesmen are in production tooling in various processes for casting and thermoforming of plastics, potting and encapsulating electronic components and in the fabrication of silicone rubber parts to meet certain endurance requirements. The compound has been extensively tested in production tooling applications and its properties are completely characterized.

Attitude Control Testing Advanced By Sophisticated Magnetic Facility

by William S. Beller

THE MAGNETIC INTERPLAY of the geomagnetic field and of controlled fields within a spacecraft, which will be used increasingly for orienting the craft, will be intensively simulated in a new and highly versatile Goddard Space Flight Center facility.

The idea to make constructive use of the geomagnetic field for spacecraft attitude control arose from the trouble the phenomenon caused on the first *TIROS* satellite. Its attitude in orbit was changed considerably by the action of the geomagnetic field on the spacecraft's magnetic moment.

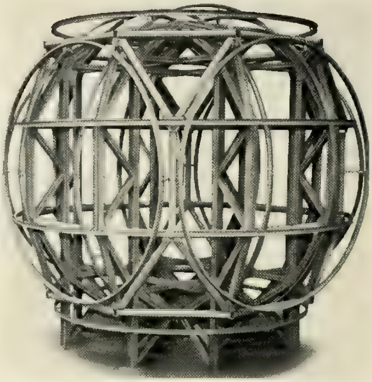
The next *TIROS* to fly had aboard a magnetic attitude control system able to be commanded from ground stations.

Sometimes the geomagnetic field induces a magnetic moment and consequently a torque into a satellite. Designers expect these effects to be conveniently small, but occasionally they are not. The *UK-2* satellite, for instance, bore ferrite loop antennas that gave rise to a highly disturbing induced magnetic moment.

As a result of experiences such as these, spacecraft engineers are trying to cooperate with nature rather than ignore it with respect to the geomagnetic field. Physicists, on the other hand, have been conscious of the way a spacecraft can distort the geomagnetic field in its locale. For this reason, they have insisted on mounting their magnetic sensors on booms. Yet even here, the field of the spacecraft may be felt. And it is in studying these effects that the new Goddard facility will be able to play another important role.

• **Nulls Earth field**—The Goddard Attitude Control Test Facility (ACTF) is expected to be operational in June, 1966. It will contain a coil system able to null the Earth's magnetic field and maintain that condition despite transients. Magnetometers will sense the changes in the Earth's field and initiate corrective changes in the coils.

The name of the facility is limiting and does not adequately describe its function. It will be used for magnetic testing far beyond what is called for in the design of magnetic attitude control systems. This is evident in the operational versatility designed into the facility.



STEEL MOCKUP of coils for Goddard's new magnetic test facility.

The coil, an arrangement of three coil subsystems, will enclose a sphere about 40 ft. in diameter. "This will be the largest such system known to exist in the world, and one of the most precise," said Leland Parsons, head of Goddard's Magnetic Test Section in the Test and Evaluation Div. He will be in charge of ACTF when it begins operations.

The facility, whose development was directed by project managers William G. Brown and G. Russell Springham, was built large in order to handle spacecraft of the size of the *Orbiting Astronomical Observatory (OAO)*. This is as big as most orbiters are expected to get within the next decade, excluding appendages. The ACTF will even be able to accommodate spacecraft of the *Nimbus* program when some of the extensions are folded or taken off so that access to the coils is permitted. The opening into the coil measures 10 ft. 3 in. square.

Up to the time Goddard completes ACTF, the center will continue to use a smaller simulator and to borrow time on the facilities at the Fredericksburg Magnetic Observatory, Fredericksburg, Va., and the Naval Ordnance Laboratory, White Oak, Md. These, however, are overloaded, and have been operating around the clock for the past 5 years to meet the needs of various spacecraft programs, according to Parsons. He indicated, too, that, with the more sophisticated spacecraft coming up for magnetic test, the new Goddard facility will be far more suitable.

• **Can rotate field**—The most significant feature of the ACTF will be its ability to produce magnetic field vectors that are either static or dynamic. The test coil will be able to cancel independently the three vectors of the Earth's magnetic field—north-south, east-west and vertical—in this way producing around the geometrical center of the system a homogeneous sphere-shaped magnetic field 6 ft. in diameter. The field would be controllable in the range from Earth ambient to zero magnetism—or, by reversing the polarity of the current supplied to it, to twice Earth ambient.

The system will also be able to generate an absolute vector from zero to 60,000 gamma in any direction. Moreover, it can make this vector rotate along any axis in three-dimensional space.

Precautions in developing the facility extended even to prescribing a non-magnetic building for housing the test coil. This building, a cube 60 ft. on a side, has no ferrous metal in it and very little other metal, in order to keep out eddy currents. The concrete used is non-reinforced, and made of a special selected aggregate that was checked at the quarry to insure that it is magnetically neutral.

• **To measure magnetic spin**—Because the control torque applicable to a satellite by a magnetic system is so small, one of the most difficult test problems is to determine the extent to which such a control can affect the spin rate of a satellite. "There is no way at the present time to evaluate such a system," Parsons told MISSILES AND ROCKETS. He said that in one test a satellite was suspended on a 60-ft.-long wire. A command was given to actuate the magnetic spin control system, but the torque produced was too weak to overcome the spring constant of the wire, and therefore no rotation occurred.

The Goddard plan is to float spacecraft on a liquid bearing within the ACTF. The magnetic field would then be rotated while the spacecraft remained static. (This is similar to the wind-tunnel technique wherein the model is kept stationary and the medium moved.) A spin-up or spin-down magnetic control vector would then be introduced, and its effect would be measured by a torque meter.

Another system, involving a torque meter, would be used to evaluate eddy current drag effects on a satellite. Such eddy current are believed to be induced in conducting material rotating in the geomagnetic field. It is considered a weak effect, and has not yet caused much trouble. But for long lifetime satellites, it could significantly decay the spin rate. This effect has not yet been measured, according to Parsons.

Aircraft Armaments, Inc., of Cockeysville, Md., is the prime contractor on ACTF.

- **New control systems**—Two forthcoming Goddard-directed satellites will have magnetometers aboard for attitude-control purposes, illustrating the need for the advanced testing facility. The *Atmospheric Explorer-B* is expected to be launched early next year, while the *Direct Measurement Explorer-A*, to be piggy-backed with an *Alouette* on the *ISIS-X* satellite, will be launched sometime this year.

Both the AEB and DMEA spacecraft will use an Applied Physics Laboratory magnetic spin rate control system and magnetic attitude control system.

The spin-rate-control system is an all new device that senses the geomagnetic vector, generates a moment at right angles to the vector on ground command, and thereby effects the required spin-up/spin-down correction.

The magnetic attitude control system operates on ground command: the magnetic moment along the satellite spin axis is varied, thereby generating a moment that changes the position of the spacecraft.

- **Other test variables**—The ACTF is designed to determine the magnetic moment of spacecraft. If that moment should prove variable for any reason, then these variations will be investigated. This means that, to take care of induced moments and other transients, the magnetic moment of spacecraft must be determined for all flight conditions.

These transients could be introduced by the fields of sub-systems interacting with the geomagnetic field, the flow of dc current within a payload package, or even by the current generated by solar cells. All these interactions—many weak and subtle, but in the long run perhaps prevailing—will be studied in the ACTF. ■

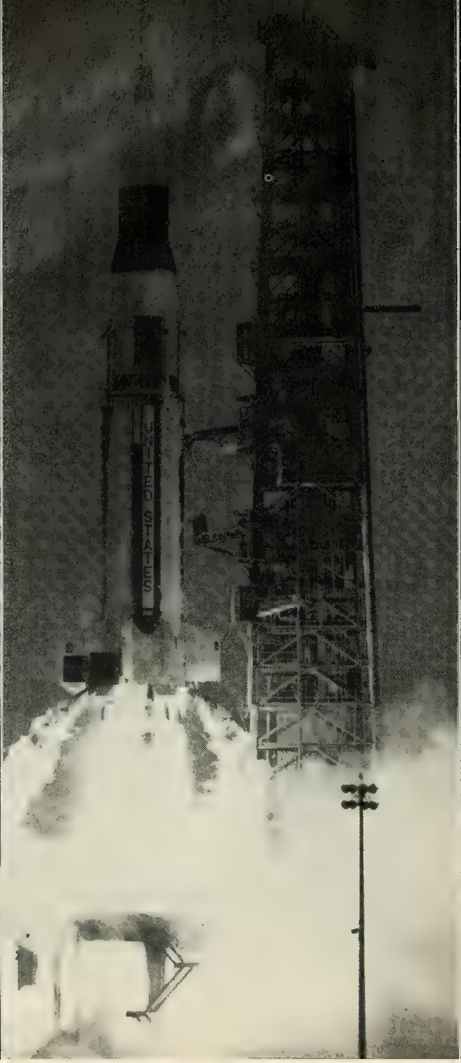
THREE COIL subsystems make up the test coil in the magnetic facility. These will provide a field able to cancel out the geomagnetic effect or provide a rotating vector.

COMPARISON OF various megnetic simulation facilities.

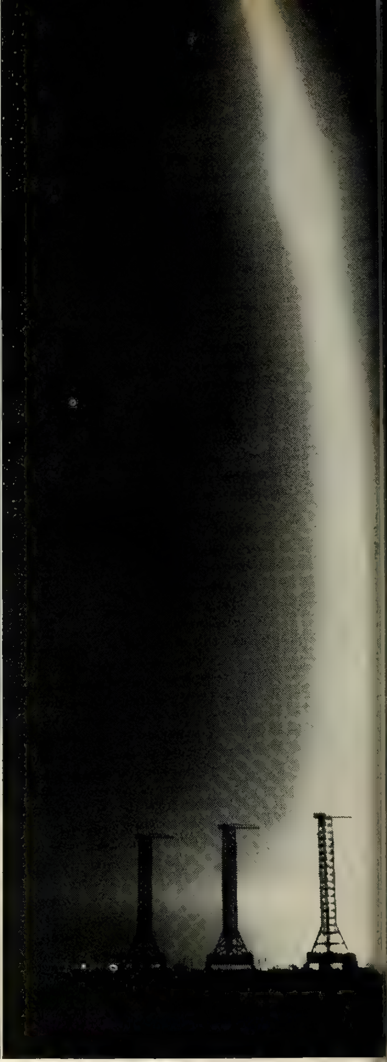
	ESTIMATED GSFC CAPABILITIES		CAPABILITIES OF EXISTING FACILITIES				
FEATURES	**Magnetic Fields Component Test Facility**	**Attitude Control Test Facility**	**Fredericksburg Magnetic Observatory Fredericksburg, Va.**	**TRW Systems Group Malibu Beach, Calif.**	**Engineering Experiment Station Annapolis, Md.**	**Naval Ordnance Laboratory White Oak, Md.**	**RCA Princeton, N. J.**
Nominal coil winding diameter	20 ft	40 ft	17 ft	20 ft	None	30 ft	10 ft
Field intensity range capability (gamma)	0-120K	0-120K	1-130K	2-500K	(8)	1-110K	(3)
Uniform field (cu ft)	14(2)	110(1)	14(4)	14(5)	(6)	(3)	(3)
Compensation for diurnal variation	Auto.	Auto.	Auto.	Man.	(6)	Man.	Man.
Resolution (compensation accuracy gamma)	0.1	0.1	0.5	2.0	3.5	1.0	(3)
Contour mapping of magnetic fields	Yes	Yes	No	No	Yes	Yes	No
Relative motion of the field	Yes	Yes	No	No	No	No	(7)
Ther.-vac. conditioning	Yes	No	No	No	No	No	No

(1) Homogeneity of 0.001% required throughout 6-ft-dia. sphere
(2) Homogeneity of 0.001% required throughout 3-ft-dia. sphere
(3) Unknown
(4) Homogeneity reported to be 7 gamma (0.12%)
(5) Homogeneity reported to be 15 gamma (0.25%)
(6) Not applicable
(7) Gimbal mount provides mechanical motion of item being tested
(8) Earth-ambient only (no coil)

SA-6 (May 28, 1964)



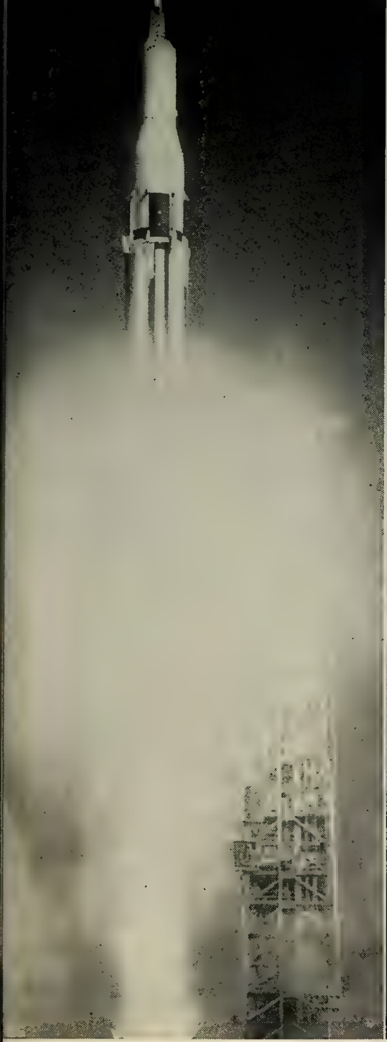
SA-7 (Sept. 18, 1964)



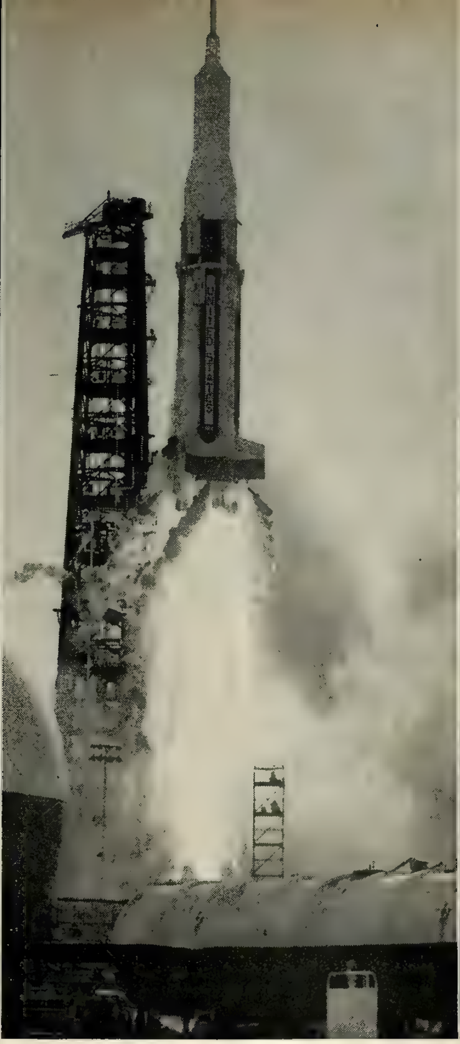
SA-8 (May 25, 1965)

When the National Aeronautics and Space Administration's Saturn IB program kicks off next year with the launch of Saturn SA-201, Bendix ST-124 inertial platforms will play a key role in guiding the mighty rockets on their missions—just as Bendix ST-124's have done with flawless performance on the last five Saturn I shots. And you can expect Bendix platforms to provide the same kind of performance on the Saturn V program that's scheduled to carry U. S. astronauts to the moon.

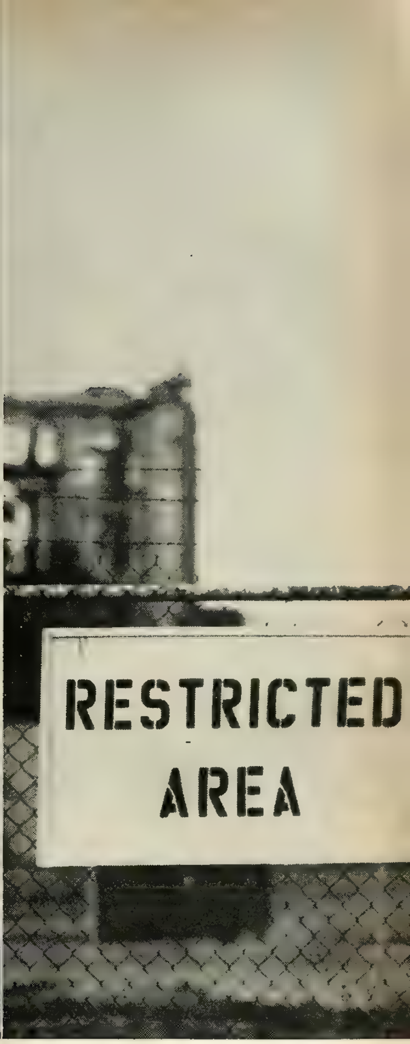
A high order of accuracy and dependability has been typical of all Bendix inertial guidance work. In addition to the Saturn record, there have been no recorded in-flight failures of our inertial guidance system in 89 firings of Army's Pershing missile. Our 16 PIGA liquid-floated Pendulous Integrating Gyro Accelerometers used on the USAF's advanced Minuteman have been described as providing one of the most accurate velocity measuring systems in existence. To state it simply, we have a record of experi-



SA-9 (Feb. 16, 1965)



SA-10 (July 30, 1965)



For the next demonstration of Bendix inertial guidance capabilities, watch the Saturn SA-201 shot.

ence and capability in inertial guidance that few, if any, can match: we are in production on inertial sensors of both liquid and gas-floated design; our inertial products range from individual sensors to stable platforms to complete systems; our in-flight performance has consistently won high level praise for accuracy, dependability and reliability; our work embraces NASA, Army and Air Force programs.

If you have an inertial guidance requirement, contact the people who offer diversity of design coupled with a performance record of proven integrity. The Bendix Corporation, Eclipse-Pioneer Division, Teterboro, New Jersey.

Engineers: We have career openings in flight control, instrumentation, guidance, systems analysis and support for aircraft, missiles and space vehicles. Send your resume attn: Technical Placement Office. An equal opportunity employer.

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Contaminant Removal Equipment Is Readied

PROTOTYPE EQUIPMENT to remove a variety of trace contaminants that might occur in spacecraft cabins is being developed and tested at Lockheed Missiles & Space Co.

The company has a contract with NASA's Manned Spacecraft Center for an *Apollo*-type unit that could be used in the program should it be found necessary, and also is doing company funded work on other units in conjunction with a two-gas environmental control unit developed by Lockheed's bioastronautics department.

A list of 88 possible contaminants has been identified by NASA for *Apollo*, based upon experience in nuclear submarines and other closed simulators. However, there has been no definition of the *Apollo* problem as yet, or whether a problem does exists.

- **Company work**—Lockheed scientists have been experimenting with a variety of contaminents that might occur with the use of different kinds of equipment. For instance, carbon monoxide might be the major contaminant with the use of some equipment. With others, it might be methane. However, a basic system has been developed that seems to meet the requirements of the varying atmospheres.

The process is a combination of sorption and catalytic oxidation. In the unit developed for use with the two-gas environmental control system, both pre- and post-sorbent beds were provided to prevent catalytic poisoning and to eliminate the introduction of undesirable products of oxidation into the cabin atmosphere. One of the project managers, T. M. Olcott, cited the possibility of such undesirable products as phosgene or hydrochloric acid, which might originate from the oxidation of freon or other compounds.

Lithium hydroxide was chosen for the pre- and post-sorbent beds. Since the *Apollo* vehicle airstream passes over an LiOH canister as part of the normal circulation, the *Apollo* unit would not require the addition of the pre-sorbent bed.

The primary contaminant sorbent is

Apollo Materials Test Described

ACCEPTABILITY of non-metallic materials for the *Apollo* Command Module is based upon a NASA test that requires that they be heated to 200°F in 100% oxygen at 5 psi for 48 hours, according to Dr. Elliott Harris, of the Manned Spacecraft Center.

After this period, a gas sample is drawn off, passed through a gas chromotograph and analyzed. Organic content is determined by a flame ionization detector. Condensable materials are isolated by evacuating the test chamber into a condensate trap, and returning noncondensables to the test chamber, Harris said. The test chamber is brought to atmospheric pressure with oxygen, and tested for odor with a Fair-Wells olfactometer. Specimen weight change is also determined.

Materials must meet these standards: Total weight loss exclusive of water must be less than 1%. Offgassing should not exceed 100 ppm by weight when expressed as pentane equivalents. After heating, the material must not have a mean order exceeding 1.5 on the basis of an olfactometric test. In this test, four panel members may rate the odor as 0—non-detectable; 1—detectable; 2—objectionable; and 3—irritating. It also must be ascertained that no observable room temperature condensate other than water is produced.

Centrinauts: a new breed of men

Despite copy book maxims, you *can* make progress while going around in circles or lying flat on your back. Several U.C.L.A. college students, dubbed "The Centrinauts," proved this fact recently in the Douglas Biotechnology Laboratory. Their reactions—heart-beat, muscle-tone, blood-pressure and others—are being taped under conditions simulating those on space missions. And Douglas scientists are gaining valuable insights from them on how astronauts will react in current manned space programs.

WEIGHTLESSNESS is simulated by floating for hours in a warm pool. The Centrinaut then takes his place in the centrifuge and is subjected to high G forces to determine whether he can "take" the strains of re-entry.

But manned spacecraft require knowledge in many scientific areas. So a wide array of Douglas laboratories are doing advanced research in fields ranging from man-machine relationships to inter-planetary space flight.

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Conduct analytical and experimental studies to determine basic aerodynamic characteristics of advanced tactical missile designs. Establish propulsion system requirements using estimated aerodynamic characteristics.

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Conduct trade-off studies of proposed missile system characteristics and evaluate complete weapon systems in their operational environment. Perform tactical evaluations of ordnance systems, develop mathematical models and measures of effectiveness.

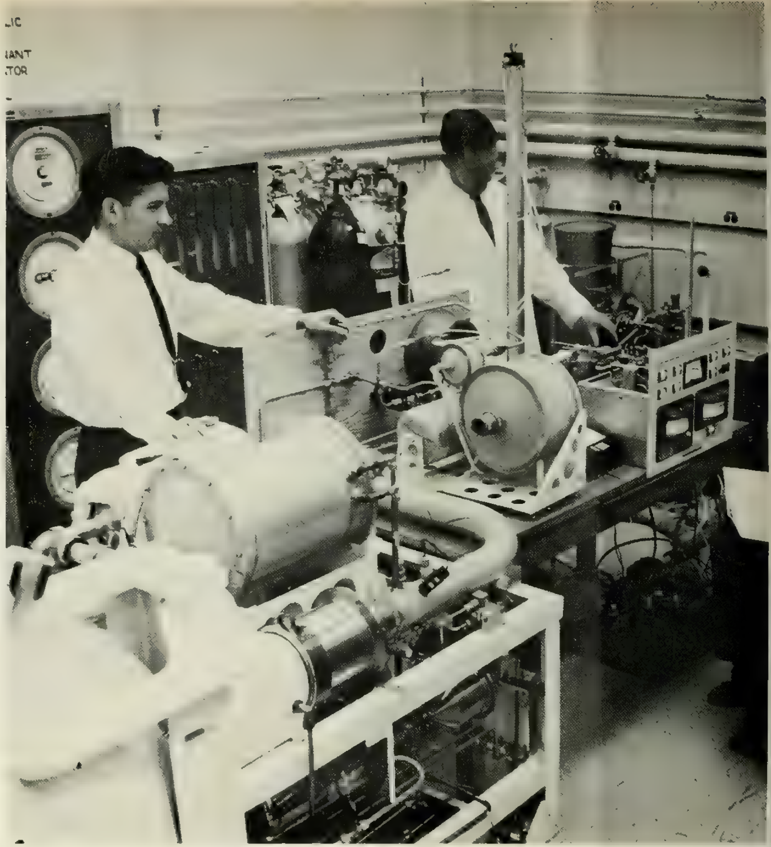
DESIGN INTEGRATION
Conduct preliminary design integration studies including interface combat logic information by flow and power distribution.

PROPULSION
Originate and conduct analyses of advanced tactical missile propulsion systems including solid, liquid and hybrid rocket engines and air breathing systems for application to advanced tactical missiles.

To investigate these opportunities, please write to: Mr. J. H. Papin, North American Aviation, Inc., Professional Employment Office, Box MR-763, 4300 East Fifth Avenue, Columbus, Ohio 43216.

All qualified applicants will receive consideration for employment without regard to sex, race, creed, color, or national origin.

North American Aviation
Columbus Division



LOCKHEED research specialist Tom Olcott, left, and co-workers. Olcott's left hand is on test equipment. His right hand rests on functioning system for providing oxygen and nitrogen for astronauts to breathe in space cabin.

activated charcoal, located in the regenerable carbon-dioxide removal unit where it is desorbed to vacuum.

The catalytic oxidier is designed to take care of those contaminants, such as carbon monoxide, methane and hydrogen, that are poorly adsorbed. The Lockheed-developed unit uses 1% platinum/1% paladium, which brings the temperature necessary to burn these contaminants down to 700°F for methane, and room temperature for carbon monoxide.

The Lockheed scientists report that CO can be converted 100% in one pass at room temperature. Methane, although it depends upon the production rate, averages about 30% per pass at 700°F.

Power input to the unit is 50 watts to maintain the catalyst temperature at the methane temperature, through the use of a regenerative heat exchanger and vacuum insulation. It also features a bypass valve to allow cool air to reach the catalyst bed should an overheat occur.

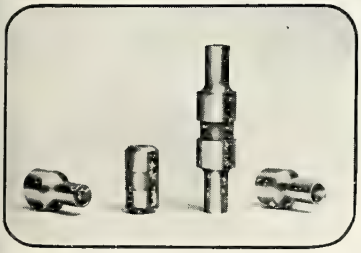
● **Testing**—Lockheed has been carrying out a series of unmanned tests of the entire two-gas regenerative life-support system, introducing gaseous contaminants through precision needle valves and capillary flow meters. These have included such contaminants as freon, ethylene, butene, vinyl chloride, methyl mercaptan, nitrogen, carbon monoxide, hydrogen sulfide, and the like. These gases are mixed in groups that are non-reactive and diluted for introduction into the system.

The two solid contaminants indole and skatole, and other water-soluble liquid contaminants are introduced in the water used for latent heat simulation. Water-insoluble liquid contaminants are mixed together and injected at a controlled rate through a motorized syringe, to vaporize in the cabin atmosphere.

Gas chromotography and wet chemical colorimetry is used to measure contaminants. In tests run at 14.7 psi oxygen/nitrogen and 5 psi oxygen, the catalytic oxidizer and sorption beds were fairly effective in keeping contaminants below allowable concentrations, although operating times have been short.

● **Other elements of system**—Lockheed's regenerative life-support system has been designed to operate with a four-man crew, assuming a re-supply

fuel cell connectors
1
2
3
You need perfection out of this world
...if you want to get back!



Operational reliability is the key phrase in space technology...the creed which brings men back to earth. At Ceramics International Corporation, a word for reliability is flawlessness.

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Manufacturing controls include the recording of all material dimensions through every fabrication step, together with all the conditions related to each operation for an absolute retraceable record. Acceptance tests include radiography for the internal detection of voids in the silver seal, and extreme voltage and resistance tests. Those parts which pass are subjected to thermal shock tests which exceed known thermal stresses experienced in space flight, thereby destroying all parts which might come anywhere near failure in flight.

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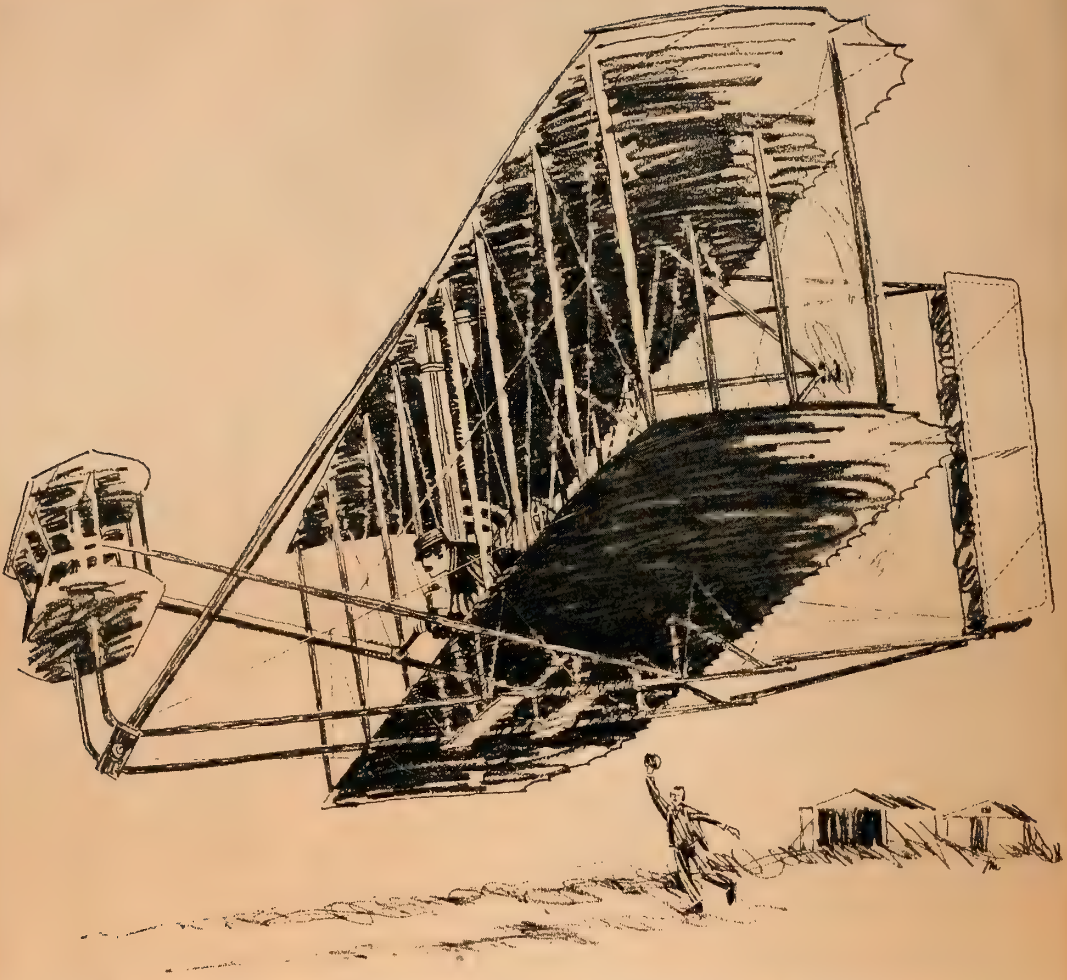

If Wilbur and Orville had Beryllium to work with, they might have made Cocoa Beach...

The fathers of modern flight had to cope with a modern aerospace design problem . . . how to make a lightweight but powerful engine. They proved man can fly—if he has the right materials to work with.

Now consider beryllium: Pound for pound one of the strongest metals known, it has magnesium's lightness . . . better stiffness than steel, but only a quarter of its weight . . . good fatigue life and excellent dimensional stability. And, with new grades of metal now available, it's easier to fabricate than ever before.

Cost? More than aluminum, magnesium or steel—at first. But if you consider increased range, payload and fuel savings, beryllium may prove to be not only the best, but perhaps the only buy for a trip to the moon or elsewhere beyond easy commuting distance.

Find out: The Beryllium Corporation of Reading, Pa. has been in the business long enough to provide *the* answers to the uses, properties, fabrications (and, yes, the limitations) of this "break-through" metal.

Why not call or write to start the information flow? Orville would have. (Wilbur was a bit conservative.) THE BERYLLIUM CORPORATION, Dept. X-5, Box 1462, Reading, Pa. 19603.

BERYLCO **Beryllium • Beryllium Copper • Beryllium Nickel • Beryllium Aluminum • Beryllium Oxide**

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period of 90 days. Oxygen partial pressure can be adjusted from 3 psi to 5 psi, and total pressure from 5 psi to 14.7 psi. Either nitrogen or helium can be used as a diluent gas. A polarographic sensor controls oxygen partial pressure, in conjunction with the controller and an oxygen solenoid valve that feeds oxygen from pressurized cylinders. The diluent gas is added on demand through a differential pressure regulator.

Although pressurized gases are being used, the company is considering adding a Sabatier reactor-electrolytic cell unit to close the oxygen loop, obtaining oxygen from carbon dioxide.

Humidity control and water separation is effected through use of a static water-gas separator using hydrophobic and hydrophilic surfaces. The former separates moisture from the gas stream, the latter ensures gas-free liquid delivery. Water is routed to a bladdered tank and exposed to a partial vacuum for withdrawal.

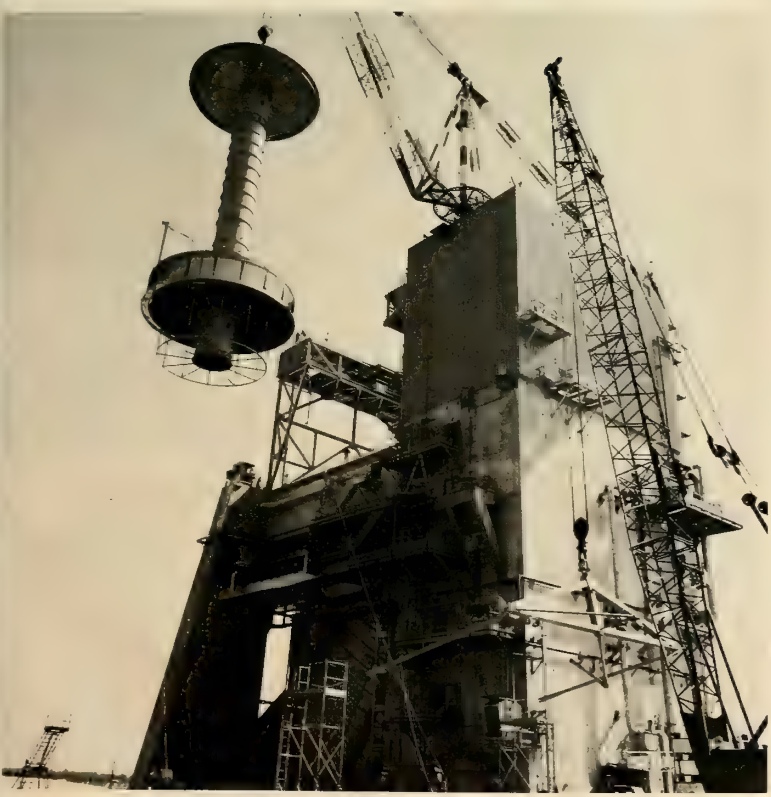
Carbon dioxide is removed by a regenerable silica gel/molecular seive unit.

Atmospheric condensate and urine are the source of water. Charcoal filtration is used to reclaim atmospheric condensate. The urine vacuum-distillation unit relies on hydrophobic and hydrophilic materials for phase separation, and derives energy for evaporation from waste heat. Non-condensible gases are vented into the simulated space vacuum.

The unit weighs about 15 lbs., requires a continuous power input of about 5 watts, and has a recovery efficiency for four men of approximately 90%.

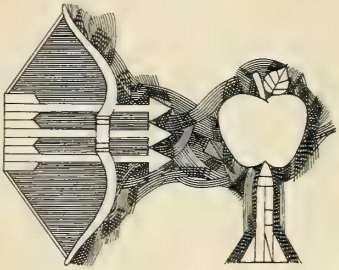
Water vapor, latent and sensible heat, contaminant and carbon dioxide production and oxygen consumption are simulated for the unmanned tests, as are the availability of a space radiator for heat dissipation, the space vacuum, spacesuit pressure drop, and the spacecraft cabin.

In tests thus far, the primary operational problems have been encountered with the regenerative CO_2 removal unit and the urine distillation apparatus. Further experimentation is planned. ■



Crews Train To Handle Saturn V Stage

FIRST TEST STAND to be used at NASA's Mississippi Test Facility is this 200-ft.-tall static stand. An S-II stage (second stage of Saturn V) simulator is being used to train crews in handling the 75,000-lb. stage. The first live rocket will be delivered this month for firing early next year.



WHERE CAN MAN GO... IN GUIDANCE & CONTROL?

Guidance and Control: able to direct the movements of satellites and space vehicles, able to home on both active and passive targets, able to interpret guidance and steering equations for ballistic missiles. And, in the final analysis, able to produce the most significant end product of all...progress. ☐ At Lockheed, progress in the realm of Guidance and Control is commonplace. In areas such as: terminal homing, control systems analysis, digital logic design, active and passive target sensing techniques, Kalman Filter Theory application and magnetic circuits. For use in ballistic missiles, satellites and space vehicles. ☐ Where can man go in Guidance and Control? Into tomorrow. ☐ If you are an engineer with Guidance and Control experience, you are invited to write Mr. K. R. Kiddoo, Professional Placement Manager, Sunnyvale, Calif. Lockheed is an equal opportunity employer.

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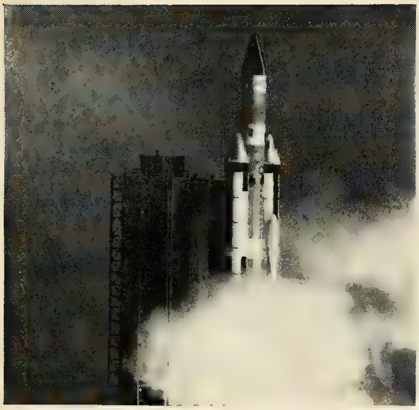
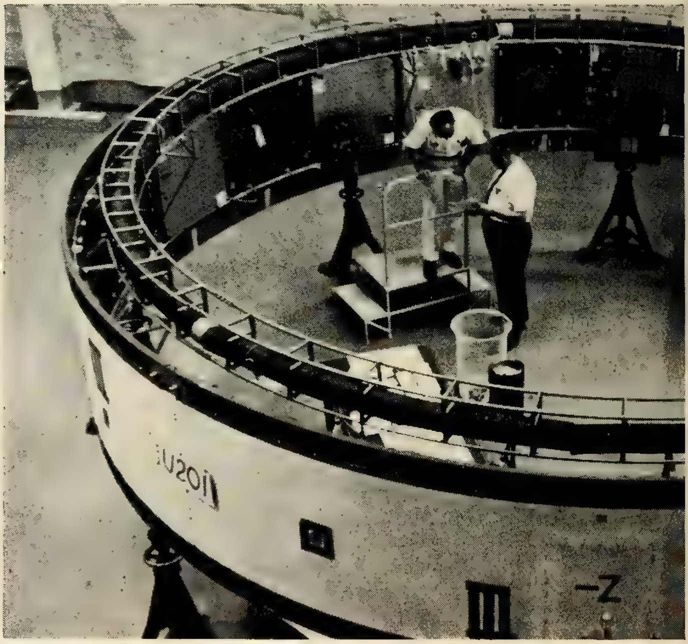
Tackling jobs like these takes systems know-how

- ☐ Steer Titan III launch vehicles from pad to orbit
- ☐ Build a nerve center for Saturn launch vehicles
- ☐ Solve down-to-earth problems from space
- ☐ Memorize all the Gemini-V flight plan alternatives



Steering Titan III launch vehicles from pad to orbit. ☐ This is the job for a compact, rugged IBM computer, a key element of the Titan III guidance system. It's from a line of IBM ASC-15 guidance computers that have flown more than 50 successful missions aboard Saturn I, Titan II and Titan III-A. ☐ Before a mission, IBM's computer checks instruments and controls. During flight, the rugged computer generates signals to correct roll, pitch and yaw to keep the vehicle on course. ☐ This IBM computer withstands the thrust of rocket blast-off and temperature extremes. And its record in the testing arena of outer space proves that it's tough, reliable and accurate.



Building a nerve center for Saturn launch vehicles. ☐ Since April, 1964, IBM has been lead contractor for this part of NASA's Saturn launch vehicle program. This is a management assignment to construct Instrument Units for Saturn 1B and Saturn V which are being developed under the direction of the Marshall Space Flight Center. ☐ The Instrument Unit is Saturn's control center. Located between the Apollo spacecraft and the upper stage of a Saturn vehicle, it controls and guides Saturn's first, second and third stages before releasing Apollo for its lunar flight. ☐ IBM's job includes designing and manufacturing data adapters and computers for the Instrument Unit, plus total systems integration and checkout of the more than 50 electronic units that make up the Saturn launch vehicle.

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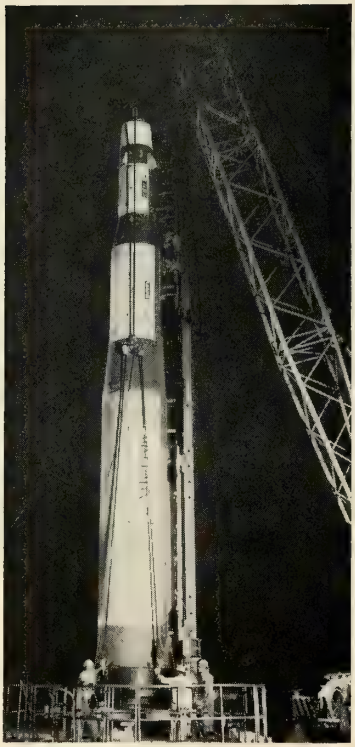
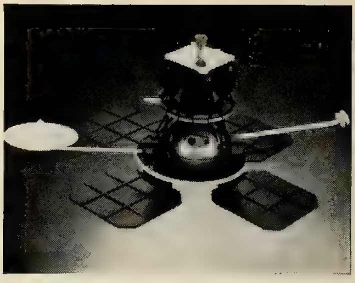
Space-Age Boeing Openings for Engineers and Scientists

Huge plastic cocoon could serve as space assembly "balloon," providing protection from solar radiation and temperature extremes. Proposal co-authored by Boeing bioastronautics scientist.



Advanced Minuteman II ICBM incorporates many improvements, including larger payload capacity, longer range, more sophisticated guidance system, increased accuracy.



First Lunar Orbiter flight, scheduled for next year, will seek out Apollo landing sites with sharp, detailed photographs of moon's surface. Boeing is building eight Orbiters for NASA.

The Boeing Company's deep involvement in the nation's most important missile and space programs is providing qualified engineers and scientists career opportunities of unusual scope and growth potential. Boeing currently is weapon system integrator for the U.S. Air Force advanced Minuteman II ICBM, prime contractor for the National Aeronautics and Space Administration Lunar Orbiter moon-scanning satellite, and a major contractor on the NASA Saturn V launch vehicle.

Aerospace Group assignments, listed in the right-hand column, are in research, design, development, manufacturing and test, and scientific and business computer technology. Requirements include a Bachelor's or advanced degree in an applicable discipline, plus related experience.

Salaries are competitively commensurate with experience and educational background. Moving and travel allowances are paid to newly hired personnel. The Boeing Company is an equal opportunity employer.

Send your resume to the employment manager at the installation(s) of your choice: Mr. L. S. Bonsteel, Boeing Atlantic Test Center, P. O. Box 1698 - AYH, Cocoa Beach, Florida; Mr. John Hall, Boeing Launch Systems Branch, P. O. Box 1680 - AYH, Huntsville, Alabama; Mr. L. Wendell Hays, Boeing Launch Systems Branch, P. O. Box 29100 - AYH, New Orleans, Louisiana 70129; Mr. John H. Taylor, Boeing Pacific Test Center, P. O. Box 1626 - AYH, Vandenberg AFB, California, or Mr. Lawrence W. Blakeley, The Boeing Company, P. O. Box 3822 - AYH, Seattle, Washington 98124.

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Assignments are in the following areas:

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Electronics Technology
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Scientific Computer Programming
Logistics Engineering
Aerospace Program Planning
Test Engineering
Electrical / Electronic Design
Materials & Processes
Human Engineering
Cryogenics
Weights Engineering
Guidance & Control
Reliability
Service Engineering
Mechanical Design
Structures Analysis & Design
Computer & Logic Circuit Development
Industrial Engineering
Electronic / Electromechanical Parts Evaluation
Computer Systems Analysis
Plant Facilities Engineering
Manufacturing Development
Welding Process Development
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Divisions: Commercial Airplane • Military Airplane • Turbine • MISSILE • SPACE • Vertol • Also Boeing Scientific Research Laboratories

ASTROLOG

Current Status of U.S. Missile and Space Programs

satellites and spacecraft

ADVANCED ORBITING SOLAR OBSERVATORY (NASA)
Republic, prime. DESCRIPTION: 1,250-lb. spacecraft to make detailed measurements of Sun's radiation; greater pointing accuracy (5 arc sec) than OSO; launch vehicle, THRUST AUGMENTED THOR-AGENA. STATUS: Development funding in FY '66 budget; two spacecraft to be launched in 1969, two in 1971.

APPLICATIONS TECHNOLOGY SATELLITE (NASA)
Hughes, prime; GE, gradient stabilization. DESCRIPTION: Five-satellite program to test communication and meteorological equipment at medium and synchronous orbit; test bed for gravity gradient communications and meteorological experiments; weight, 780 lbs.; launch vehicle, ATLAS-AGENA. STATUS: Development; first flight scheduled for late 1966.

APOLLO (NASA)
North American, Command & Service modules, systems integration; Grumman, Lunar Excursion Module (LEM); MIT, guidance development; AC Spark Plug, guidance prime; Collins Radio, telecommunications; Honeywell, stabilization & control; AiResearch, environmental control; Northrop-Ventura, parachute recovery; Lockheed Propulsion Co., escape tower rocket; Marquardt, reaction controls; IBM, realtime computer complex; Westinghouse, power conversion equipment. Lunar Excursion Module, prime, Grumman; descent engine, TRW Systems Group; ascent engine, Bell Aerosystems; environmental control, Hamilton Standard; reaction control thruster, Marquardt; guidance, MIT; radar & communications instruments, RCA; TMC, telemetry, Radiation Inc.; fuel cell, Pratt & Whitney; external visual display, Forand Optical; GE, acceptance checkout reliability; rendezvous optical system, Hughes. DESCRIPTION: Three-man spacecraft for Earth-orbital, lunar-orbital and lunar-landing missions. Boosters: SATURN I and SATURN IB for Earth orbits; SATURN V for lunar rendezvous and landing missions; 3-modular spacecraft: Command Module weight, 5-1/2 tons; Service Module, 25 tons; Lunar Excursion Module, 15 tons; total weight, 95,000 lbs. STATUS: First of a series of unmanned orbital tests began with a boilerplate model launch of SA-7, Sept. 18, 1964; LITTLE JOE II unmanned abort test successful, Dec. 8, 1964; lunar orbits scheduled 1968; lunar landing by 1970; first manned orbital flight due last half of 1966.

APOLLO EXTENSION SYSTEMS (NASA)
No contractors named. DESCRIPTION: APOLLO spacecraft would be modified to provide extended life support and battery capability; two tanks would be removed from the service module propulsion section to provide room for additional consumable supplies; ascent stage of Lunar Excursion Module for extended operations in lunar orbit and on the lunar surface; many experimental payloads have been proposed, including orbiting telescopes, survey, mapping communications and many others. Boosters: SATURN IB and SATURN V. STATUS: RFP for preliminary program definition for the payload integration work is imminent from the Manned Spacedraft Center; later it is expected that Marshall Space-flight Center will be given responsibility for lunar surface operations; 20 flights are planned beginning in late 1968.

ATHENA (Air Force)
Atlantic Research, prime; Honeywell, guidance. DESCRIPTION: 17,500-lb. four-stage re-entry vehicle, attains apogees from 600,000 to 1,000,000 ft.; last two stages drive vehicle and payload Earthward at near-ICBM velocities; major diameter, 32 in.; velocity package diameter, 28 in.; length, 51 ft. First-stage engine, Castor XM33 (Thiokol); second stage, either X261 (Thiokol) or X259 (Naval Propellant Plant); third stage, 30KS 8000(Aerojet); fourth stage, Ranger Retro BE3, Hercules. STATUS: Engaged in sub-scale testing of advanced re-entry concepts; 77 launches schedules; more than 15 have been flown from Green River, Utah, site into White Sands Missile Range, N.M.; last flight Aug. 20.

BIOSATELLITE (NASA)
GE, prime. DESCRIPTION: 1,000-lb. satellites to test effects of space environment on plants, animals (primates) and other biological specimens; launch vehicle, THRUST-AUGMENTED DELTA. STATUS: Six flight models to be built; first flight in December, 1965; others to follow at three-month intervals; fourteen experiments selected for first flight.

COMSAT CORP. SATELLITE PROGRAM
Proposals due Oct. 25 for advanced satellite for worldwide system to be launched in either synchronous orbit or medium-altitude orbit from 6,000 to 12,000 mi. Satellite weighing 240 lbs. Satellite would have capacity for 1,000 two-way voice circuits and minimum 5-year life; to be launched singly or in groups of four to six by single rocket. System to be operational by late '67 or early '68. Contract may be awarded late this year or early '66.

DISCOVERER (Air Force Program 622A)
Lockheed, prime; GE, re-entry vehicle. DESCRIPTION: THOR-AGENA and ATLAS-AGENA launchings of stabilized satellites; main purpose is to test techniques and components for military space systems. STATUS: All data on program classified as part of DOD information policy; however, indications are that program has been cut back or ended as more economical vehicles have come into use.

EARLY BIRD (Comsat Corp.)
Hughes, prime. DESCRIPTION: Experimental modified syncom to be placed in 22,300-mi. stationary orbit and provide 240 two-way telephone channels between U.S. and Europe or simultaneous transmission of 22 or more telegraph messages; booster, THRUST-AUGMENTED DELTA. STATUS: Operational; first satellite successfully launched into synchronous orbit, April 6. Second satellite may now be launched this year.

ECHO (NASA)
Langley Research Center, prime. DESCRIPTION: ECHO 1,135-ft. inflatable sphere in 700- to 805-mi. orbit; passive communication satellite; booster, THOR for ballistic tests; THOR-AGENA for orbital. STATUS: Program complete; ECHO I in orbit since Aug. 12, 1960; two ballistic shots in 1962 unsuccessful; ECHO II launched from Vandenberg Jan. 27, 1964; U.S.-USSR conducting series of cooperative experiments using ECHO.

FIRE, PROJECT (NASA)
Republic, re-entry package; Ling-Temco-Vought, velocity package; General Dynamics/Convair, launch vehicle and systems integration. DESCRIPTION: Re-entry probe to measure environmental heating at lunar return speeds (25,000 mph); launch vehicle, ATLAS D plus Antares II A-5 (re-entry booster). STATUS: R&D; first flight April, 1964, successful; second flight May 22, 1965, also successful.

GEMINI (NASA)
McDonnell, prime; Rocketdyne, spacecraft propulsion; General Electric, fuel cell; IBM, guidance system integration and computer; Honeywell, guidance; Westinghouse, rendezvous radar; AiResearch, environment. DESCRIPTION: Bigger and heavier MERCURY-type capsule to

carry two men for up to two weeks; TITAN II used as booster; ATLAS-launched AGENA will be used for rendezvous missions; 15 spacecraft will be produced. STATUS: Development; 12 flights planned; will be used to determine feasibility of rendezvous for lunar mission and long-duration manned flight; first unmanned flight, April, 1964, successful; second unmanned orbital flight, January, 1965, successful; first manned flight successful March 23; second flight successful, June 3-7, 1965, including first extravehicular activity; eight-day GEMINI V flight, Aug. 21-29, set world record for manned spaceflight duration; two more flights scheduled this year; manned and rendezvous flights, 1966-67; AF participating in program, and will modify GEMINI capsules for MANNED ORBITING LABORATORY.

GEOS (NASA)

Applied Physics Laboratory, prime. DESCRIPTION: 350-lb. geodetic satellite (similar to ANNA) to carry flashing-light beacons, electronic beacons and optical and radar reflectors; launch vehicle, IMPROVED DELTA; 700-900-mi. orbit at a 59-degree inclination. STATUS: First flight planned in third quarter 1965. PAGEOS passive satellite developed by Langley Research Center will also be launched in the first half of 1966.

HYPERSONIC RESEARCH VEHICLE (AF, NASA)

No contractors announced. DESCRIPTION: Manned hypersonic spacecraft capable of Earth-to-orbit-and-return; turbofan, Mach 0-3; ramjet, Mach 3-8 or 10 (oxygen collected and liquefied during this cycle); Mach 8-10 orbital speeds, LH$_2$-LOX rocket. STATUS: Joint NASA-AF research program approved; NASA funding $5 million in FY '66; AF has advanced technology program in six pertinent areas (mostly engine developments) in FY '65. GE, Pratt & Whitney and Marquardt selected for conceptual and preliminary design of a research engine; engine flight test planned for early 1968.

ICBM ALARM (Formerly MIDAS) (Air Force Program 239A)

Lockheed, prime; Aerojet, IR detector system. DESCRIPTION: Early-warning random-orbit satellite; detect ICBM launchings by IR; two flights conducted in 1963 detected solid and liquid missile launches; satellites are launched piggy-back on various AF boosters. STATUS: Development; no decision on deployment; reportedly competing with over-the-horizon radar; Air Force is currently studying requirements for a new, multi-function satellite, combining the functions of MIDAS and SAMOS.

INTERPLANETARY MONITORING PLATFORM (NASA)

Goddard Space Flight Center, prime; Martin Co. developing nuclear power unit. DESCRIPTION: 131-181-lb. satellite launched into cis-lunar-space orbit with an apogee of more than 100,000 mi.; will measure radiation and solar flare hazards in advance of Project APOLLO; launched by DELTA and THRUST-AUGMENTED DELTA boosters from AMR. STATUS: IMP-I launched in December, 1963; IMP-II launched Oct. 3; five more satellites are planned, two to be placed in lunar orbit; later flights will use a nuclear power unit as replacement for solar cells; Designation, IMP-A is EXPLORER XVIII; IMP-B is EXPLORER XXI.

ISIS (Canada, U.S.)

Canadian Defense Research Board, satellite; NASA, launch vehicle. DESCRIPTION: Three-satellite follow-on program to ALOUETTE to continue ionospheric studies. STATUS: Design of ISIS A began in 1964 with launch planned in 1967; B and C to be launched in 1968, 1969; launch vehicle, THOR-AGENA.

LES (Air Force)

M. I. T. Lincoln Laboratory, prime; consulting support, TRW Systems Group. DESCRIPTION: a series of Lincoln Experimental Satellites carried as TITAN III-A and III-C "bonus" payloads to test military comsat devices and techniques. STATUS: First launch Feb. 11 failed; second, May 6, achieved orbit.

LUNAR LOGISTICS SYSTEM (NASA)

Studies have been conducted by Grumman, TRW Systems Group and Northrop. DESCRIPTION: Spacecraft to carry support payloads to the Moon. Two designs under study—LEM truck with 7,000-lb. payload and logistics spacecraft with 25,000 to 30,000-lb. payload; booster, SATURN V. STATUS: Program definition of the LEM truck planned in FY '67; program would cost about $1 billion; first step will be to extend lunar stay-time up to two weeks.

LUNAR ORBITER PHOTO CRAFT (NASA)

Boeing, prime; RCA, power and communications; Eastman Kodak, cameras; Marquardt, maneuvering engine. DESCRIPTION: 800-lb. spacecraft launched by ATLAS-AGENA will orbit Moon, taking pictures of lunar surface; radioactive and geodetic measurements will also be taken. STATUS: Five flights scheduled beginning in mid-1966.

MANNED ORBITING LABORATORY (Air Force)

Douglas Aircraft Co., prime; GE, on-board experiments. DESCRIPTION: Two-man spacecraft to establish military usefulness of man in space; booster, TITAN III-C; GEMINI-X capsule atop 10-ft.-dia., 41-ft.-long canister lab; total weight about 25,000 lbs.; orbit below 350 mi; flights of 30 days in shirt-sleeve environment planned. STATUS: Douglas named Aug. 25 to develop and build MOL; GE named at same Presidential news conference to develop space experiments to be carried; $150 million in FY '66 funding; unmanned GEMINI canister launch, late 1966 or 1967 using recovered GEMINI capsule; manned GEMINI canister launch, 1968; rendezvous and ferry capability possible. APOLLO hardware components will be used with GEMINI in broadened MOL concept.

MARINER (NASA)

Jet Propulsion Laboratory, prime. DESCRIPTION: 570-lb. unmanned spacecraft for early interplanetary missions to vicinity of Mars and Venus; boosted by ATLAS-AGENA. STATUS: First scheduled Venus fly-by, August, 1962, unsuccessful after booster failure; second passed within 21,594 mi. of Venus, Dec. 14; two Mars fly-by spacecraft launched in November, 1964; first on Nov. 5 failed due to shroud malfunction; MARINER IV launched Nov. 28, flew by Mars July 14, 1965, and transmitted the first close up photos of the planet; because of press of maintaining APOLLO schedules, NASA has dropped plans for 1966 Mars shot; agency will go directly to VOYAGER, a 7,000-11,000 lb. spacecraft for missions in 1970's, with a test flight in 1969.

MILITARY COMMUNICATIONS SATELLITE (Prog. 369) (AF,DCA,Army)

Aerospace Corp., systems engineering & technical direction; Philco, prime. DESCRIPTION: Multiple-launch, random, active repeater comsat; 24 satellites launched in groups of 8 satellites in 18,300-n.mi. polar orbits; weight about 100 lbs.; TITAN III-C booster. STATUS: Full-scale development as an "interim" system which is to be in operation in 1966. DCA has requested ideas from industry on a longer-lived Advanced Communication Satellite system; FY 1968 operational status planned.

NATIONAL ORBITING SPACE STATION (NASA, AF)

Many studies awarded. DESCRIPTION: Manned space station with orbital lifetime of one to five years for testing components and techniques in the space environment; weight ranges under study vary from 15,000-20,000 up to 200,000 lbs. STATUS: Decision not expected for one to four years. MANNED ORBITING RESEARCH LABORATORY and LARGE ORBITING RESEARCH LABORATORY being considered.

NIMBUS (NASA)

Goddard Space Flight Center, prime; GE, integration and testing; RCA, vidicon cameras. DESCRIPTION: 900-1,100-lb. second-generation weather satellite; Earth-stabilized polar orbiting; TV cameras and IR scanners in payload; THRUST-AUGMENTED THOR-AGENA B booster. STATUS: First launching successful Aug. 28, 1964; picture & IR quality good in spite of satellite's elliptical orbit; satellite quit transmitting Sept. 23; second scheduled in 1966, third in 1967 and fourth in 1968-69.

NUCLEAR DETECTION SATELLITES (Formerly Vela) (ARPA)

TRW Systems Group, prime; Los Alamos Scientific Lab/Aerospace Corp., payload. DESCRIPTION: 20-sided, 485-lb. satellite for detection of nuclear explosions in space; 50,000-mi. orbit; booster, ATLAS-AGENA; launched in pairs. STATUS: First pair successfully launched in October, 1963; second pair successfully launched July 17, 1964; three pairs remain.

ORBITING ASTRONOMICAL OBSERVATORY (NASA)

Grumman, prime; Westinghouse, ground station, components; GE, stabilization and control; Kollsman, star trackers; IBM, data processor and storage; Hughes and Avco, communications equipment. DESCRIPTION: 3,600-lb. orbiting astronomical satellite to study ultraviolet spectrum from approximately 1,200 Å to 4,000 Å; four major experiments selected; one piggyback; booster, ATLAS-AGENA D. STATUS: Three flights beginning in late 1965.

ORBITING GEOPHYSICAL OBSERVATORY (NASA)

TRW Systems Group, prime; DESCRIPTION: 1,000-lb. satellite with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; can carry more than 20 experiments; ATLAS-AGENA THRUST-AUGMENTED THOR, booster. STATUS: First launch Sept. 4, 1964, partially successful; 16 of 20 experiments working; five other launches planned, with next flight scheduled for second half of 1965.

ORBITING SOLAR OBSERVATORY (NASA)

Ball Brothers, prime. DESCRIPTION: OSO 1,458-lb. orbiting solar observatory; OSO II, 535-lbs.; booster, DELTA; S-16 early version; S-17 and S-57 advanced versions. STATUS: First flight March 7, 1962, highly successful; second flight, Feb. 27, 1965, successful. Third satellite, launched Aug. 25, failed to achieve orbit because of premature third-stage ignition, six more flights planned.

PEGASUS (NASA)

Fairchild Hiller, prime. DESCRIPTION: 3,400-lb. meteoroid-detection satellite employing two 50 x 15 ft. extendable detector wings; Earth orbit 300 to 800 mi.; booster, SATURN I. STATUS: Development; will measure size, energy and frequency of meteoroids to evaluate hazards of impact with manned spacecraft; first launch successful in February; PEGASUS B, May 25, 1965, and PEGASUS C, July 30, 1965, also successful. No more launches planned; formerly known as METEORIOD DETECTION SATELLITE.

PIONEER (NASA)
TRW Systems Group. DESCRIPTION: 130-lb. spin-stabilized solar probe; AUGMENTED DELTA launch vehicle; cylindrical; covered with 10,000 solar cells; four outrigger booms for stabilization; five experiments, 60 to 90-million-mi. communication capability. STATUS: Seven launches in program; late-1965 launch schedule set; orbits range from 0.8 to 1.2 au for 6-mo. lifetime; EXTENDED PIONEER under study.

PROJECT SCANNER (NASA)
Honeywell, fabrication and integration; Baird-Atomic, star-mapper telescope; Santa Barbara Research Center, dual radiometers. DESCRIPTION: Unmanned scientific satellite to measure natural radiation gradients of Earth's horizon to determine utility of spacecraft horizon sensors. STATUS: Flights to begin in 1965.

RADIO ASTRONOMY EXPLORER (NASA)
Goddard, prime for first two spacecraft with industry to build remaining four. DESCRIPTION: 270-lb. satellite which will have four 750-ft. extendable antennas to pinpoint radio emissions in space. STATUS: Hardware funding approved in FY '65 & '66 budgets, with first launch by a THRUST-AUGMENTED DELTA in 1967.

RANGER (NASA)
JPL, prime; Hercules, retro-rocket; Northrop, support contractor; RCA, TV system. DESCRIPTION: Before impact, TV cameras take pictures of lunar surface; ATLAS-AGENA B booster. STATUS: RANGER VI launched Jan. 30, 1964, TV system failed; RANGER VII launched July 28, 1964, and impacted Moon after transmitting 4,316 pictures back to Earth; RANGER VIII launched Feb. 17, 1965, impacted Moon Feb. 20, after transmitting more than 7,000 pictures; RANGER IX launched March 21; struck Moon March 24 after transmitting 5,814 photos; program now complete.

RELAY (NASA)
TRW Systems Group, project coordination and systems planning; RCA, prime. DESCRIPTION: 172-lb. spin-stabilized wideband 800 to 4,600-mi.-orbit active repeater experimental communications satellite; booster, DELTA; STATUS: Britain, France, Brazil and Germany building ground stations; first launch, Dec. 13, 1962; RELAY II launched Jan 21, 1964; program completed.

SAMOS (Air Force Program 720A)
Lockheed, prime; photo intelligence equipment, Eastman Kodak; capsules, GE; parachute and guidance recovery equipment, Avco and Northrop Ventura. DESCRIPTION: Reconnaissance satellite; formerly SENTRY; R&D model weighs 4,100 lbs. with E-5 capsule (3,000 lbs. with E-6); booster, ATLAS-AGENA; 100-300-mi. circular polar orbit. STATUS: Operational; advanced SAMOS under development; a successor system, capable of changing orbital plane and altitude on command, is apparently being developed; this newer reconnaissance satellite would have up to six recoverable data capsules or cassettes with lifting-body characteristics, permitting data recovery without returning entire satellite to earth; could be launched by the TITAN III-X booster now under development; FERRET version used for electronic intelligence and communications eavesdropping.

SATAR (Air Force)
General Dynamics, prime. DESCRIPTION: 300-lb. scientific satellite pod mounted on side of ATLAS booster; length, 55 in.; diameter 27 in.; 200-lb. payload; orbits vary from 500 to 2,000 n. mi.; as re-entry vehicle, gains speeds up to 30,000 fps; guidance, strap-down system with three orthogonally mounted gyros; unstabilized when in orbit. STATUS: Development; seven vehicles being built under present contract; pods of SATAR type have been flown on 44 missions.

SATELLITE INSPECTOR (Air Force PROGRAM 706)
No contractors announced. DESCRIPTION: Satellite inspection system consisting of a spacecraft capable of co-orbital inspection of non-cooperative satellites. STATUS: Re-oriented from unmanned vehicle to manned satellite using GEMINI; Conceptual preliminary design studies under way; early GEMINI flights expected to provide important inputs; $2 million in FY '65 budget.

SECOR (Army)
Cubic Corp., prime, transponder and ground stations; ITT Labs, satellite vehicle. DESCRIPTION: 40-lb. geodetic satellite; rectilinear, measuring 9 x 11 x 14 in.; can be carried piggyback on a variety of boosters; frequency, 162-324 mc for geodetic measurements; 54-216 mc for refraction studies. STATUS: Operational SECOR vehicles 1, 3, 2, 4 and 5 now in orbit, launched in order of mention. SECOR 5, launched Aug 10, 1965, is the only non-rectilinear satellite in the series, being a 20-in. polished sphere; future SECORs will be rectilinear; expanded program at altitudes of 1,800 mi. is being considered.

SERT (NASA)
RCA, prime. DESCRIPTION: Spinning ballistic test vehicle carrying two electric-propulsion engines for environmental tests. STATUS: First flight July 20, 1964, from Wallops Island, Va., carried a Lewis electron bombardment engine and a Hughes contact ionization engine; the Lewis engine worked well while Hughes engine produced no thrust; follow-on flights cancelled since SERT I proved neutralization of an ion beam in space; SERT III now under study.

START (Air Force)
Award in only one of an expected 10-14 areas has been announced; Martin Co. for work on a vehicle related to the in-house SLV-5; Aerospace Corp., general systems engineering and technical direction. DESCRIPTION: An experimental program, much broader than ASSET, to explore the materials, structures, flight regimes and other areas related to glide atmospheric entry. STATUS: Program package is still being assembled.

SURVEYOR (NASA)
Hughes, prime; Martin, SNAP device. DESCRIPTION: 2,150-lb. spacecraft for soft-landing 100-300 lbs. of instruments on Moon; nine 2,500-lb. spacecraft are also planned; booster, ATLAS-CENTAUR; SNAP nuclear generator optional. STATUS: First Moon flights early 1966; five soft-landing vehicles planned in Block I series; 17 flights scheduled.

SYNCOM (NASA)
Hughes, prime. DESCRIPTION: 24-hr.-orbit instantaneous narrow-band, active-repeater communications satellite; 28 in. in dia. and weighs about 63 lbs.; booster, DELTA; capable of accommodating one full duplex radio telephone channel. STATUS: First launch failed, Feb. 14, 1963; satellite believed to be in orbit but contact lost; SYNCOM II launched July 26, 1963, completely successful; third launch Aug. 19, 1964, successful; satellite, positioned in stationary orbit over Pacific, relayed 1964 Olympic Games to U.S. from Japan; program now complete. DOD has taken over satellites for military traffic.

SMS (Synchronous Meteorological Satellite) (NASA)
Republic, RCA Astro-Electronics, Hughes, study contracts. DESCRIPTION: 24-hr. weather satellite, Earth-stabilized; TV cameras with variable focus; may use SNAP-50 for power; booster may be ATLAS-AGENA or -CENTAUR. STATUS: Studies to continue; development funds not included in FY '66 budget; ATS and TIROS expected to provide major inputs to the program.

TELSTAR (AT&T, NASA)
Bell Telephone Laboratories, management for AT&T. DESCRIPTION: 170-lb. active repeater experimental industry communication satellite; DELTA booster. STATUS: Development; first launch July 10, 1962, highly successful; second launch May 7, 1963, also successful; program now complete.

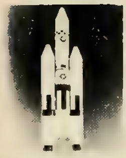
TIROS (NASA, Weather Bureau)
RCA, prime. DESCRIPTION: 285-lb. meteorological satellite; TV pictures of cloud cover; IR sensors to gather heat balance data; one TIROS to be tested for effectiveness in highly elliptical orbit (300-3,000 mi.). STATUS: R&D; ten satellites launched; all successful; four more launches planned with TIROS wheel configuration (Earth-stabilized) to serve as an interim National Operational System.

TRANSIT (NAVY)
Applied Physics Laboratory, prime; Martin, SNAP device; Westinghouse, shipboard satellite signal receivers. DESCRIPTION: Navigational satellite; R&D model over 250 lbs.; operational, 50 to 100 lbs.; operational system; four satellites in random, near-circular 600-mi. orbits; SNAP nuclear generator; ABLESTAR, SCOUT booster. STATUS: Four-satellite system operational since July, 1964; system established for use by POLARIS subs and surface ships; two nuclear-powered (SNAP-9A) satellites launched in 1963; NASA exploring feasibility of commercial system.

TRS (Air Force)
TRW Systems Group. DESCRIPTION: 3-lb. scientific satellite to measure radiation; four-sided, measuring 9 in. on a side. STATUS: Operational; first launched piggyback on DOD payload Oct. 17, 1963.

VOYAGER (NASA)
Either Boeing, GE, or TRW Systems Group will be selected for spacecraft program definition later this year. DESCRIPTION: Unmanned 7,000-11,000-lb. MARINER follow-on spacecraft bus/lander to orbit Mars and eject a capsule to the surface. STATUS: Development expected to begin in early 1966; program definition funded in FY '66; launches in 1971-73 period; spacecraft to be launched by SATURN IB/CENTAUR, and will be used to explore other planets through 1970's.

X-15 (NASA, AF, NAVY)
North American, prime; Thiokol, propulsion; Sperry Gyroscope, inertial flight data system; Honeywell, adaptive flight control electronics. DESCRIPTION: Manned rocket plane capable of 4,000-mph-plus flight at edge of space; single rocket engine develops 57,000 lbs. thrust. STATUS: Powered flights in progress; unofficial records set—altitude 354,200 ft. and speed 4,104 mph; hypersonic propulsion research program should run through 1968; more than 100 flights have been made; ramjet (X-15A2) flights scheduled for 1968.



space vehicles

ABLESTAR (Air Force)
Space-General, prime; Aerojet, propulsion; Space-General/Bell Telephone, guidance. DESCRIPTION: 2,000-lb. upper stage; 9.5 ft. long; 55 in. dia.; radio command guidance; propellants, UDMH/IRFNA; restart capability. STATUS: Used in TRANSIT and other military programs; THOR booster.

ATLAS-AGENA D (Air Force)
General Dynamics/Astronautics (ATLAS); Lockheed (AGENA); TRW/STL, AGENA B; Honeywell, inertial reference. DESCRIPTION: 275,000-lb. booster; payload capability, 5,000 lbs., in 345-mi. orbit, 750 lbs. to escape, length, 102 ft.; base diameter, 10 ft.; liquid propulsion; modified ATLAS D with 360,000-lb. thrust; AGENA B with 15,000-lb. thrust; restart capability. STATUS: Operational; used in RANGER, DISCOVERER, MILITARY COMSAT, MARINER, LUNAR ORBITER, OAO, SAMOS and other programs. ATLAS Standard Launch Vehicle developed for AF space programs; ATLAS launches from WTR being used in conjunction with ATHENA launches at Green River, Utah, in an effort to develop scaling laws for re-entry bodies (Advanced Ballistic Re-entry Systems program).

AGENA D (Air Force)
Lockheed, prime; Honeywell, guidance; Bell, propulsion. DESCRIPTION: 1,700-lb. upper stage; 25 ft. long; 5 ft. dia.; all-inertial guidance; propellants, UDMH/IRFNA; multiple re-start capacility; ATLAS, THOR and THOR-augmented boosters. STATUS: Used in DISCOVERER, SAMOS and other military programs as well as a variety of NASA programs; e.g., MARINER, RANGER, OAO and OGO.

CENTAUR (NASA)
Lewis, program management; General Dynamics/Convair, prime; Pratt & Whitney, propulsion; Honeywell, guidance. DESCRIPTION: High-energy upper stage using a pair of RL-10 LOX/liquid hydrogen engines; 30,000 lbs. total thrust; 30 ft. long; 10 ft. dia.; ATLAS D booster; capable of orbiting 8,500 lbs.; 2,300 lbs. to escape; 1,300 lbs. on planetary flights. STATUS: Development; first flight failed; second launch Nov. 27, 1963, successful; third, June 20, 1964, partially successful; fourth flight Dec. 11, 1964, successful; Dec. 11; fifth flight Mar. 2 failed when ATLAS-CENTAUR exploded on pad; CENTAUR 6, Aug. 11, 1965, successful; one more flight set for 1965; vehicle to become operational in 1965.

DELTA (NASA)
Douglas, prime; Bell Telephone Labs, guidance; Rocketdyne/Aerojet/Allegany Ballistics Laboratory, propulsion. DESCRIPTION: Successor to THOR-ABLE; upper-stage guidance; three-stage vehicle; 800-lb. payload capability in 100-mi. orbit; THRUST-AUGMENTED DELTA payload capability 1,500-plus lbs. in 100-mi. orbit; THOR missile comprises first stage. STATUS: Launch vehicle for TIROS, EXPLORER, OSO, BIOS, ECHO; TAD used for SYNCOM & PIONEER; 26 previously on order augmented by AF order for 21 more for NASA; THRUST-AUGMENTED DELTA with three solid motor strap-ons also being used.

LITTLE JOE II (NASA)
General Dynamics/Convair, prime. DESCRIPTION: Solid-propelled vehicle with 800,000-lb. thrust; launch vehicles for APOLLO suborbital flights. STATUS: Four launches Aug. 28, 1963, May 13, 1964, Dec. 8, 1964, May 19, 1965, successful; six vehicles ordered thus far.

POST-SATURN V LAUNCH VEHICLE (NASA)
Under study. DESCRIPTION: No firm concept but will be significant improvement over SATURN V (20-30 million-lb.-thrust first-stage large solid motors, and nuclear upper stage under consideration). STATUS: Study to determine characteristics; operational target date post-1975.

ROVER (NASA, AEC)
Los Alamos Scientific Labs, ROVER prime; Aerojet, NERVA prime; Westinghouse, propulsion. DESCRIPTION: First nuclear rocket; tests of Kiwi, prototype of NERVA engine, under way. STATUS: Kiwi tests completed this year; NERVA tests highly successful; full systems tests of engine now set for fall, 1965—12 months ahead of schedule; development of Phoebus reactor initiated; no flight test program funded at present.

SATURN I (NASA)
Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler Corp.; S-IV, Douglas. DESCRIPTION: Two-stage vehicle for early boilerplate tests of APOLLO and PEGASUS; first stage: eight Rocketdyne H-1 engines; second stage: six Pratt & Whitney RL-10-A3 engines; 22,500 lbs. into 345-mi. orbit. STATUS: Four flight tests of first stage successful; all flights with inert upper stage; first flight with live upper stage successfully launched Jan. 27, putting 37,700 lbs. in low Earth orbit; SA-6 May 28, 1964 and SA-7 Sept. 18, 1964, also successful; SA-9 on Feb. 16 put PEGASUS satellite into orbit; SA-8, May 25, and SA-10, July 30, 1965, also successful, completing R&D program.

SATURN IB (NASA)
Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler; S-IVB stage, Douglas. DESCRIPTION: S-1, eight H-1 engines; S-IVB, one J-2 engine; payload capability, 35,000 lbs. in 105-mi. orbit. STATUS: Development; first flight in 1966; boost APOLLO spacecraft boilerplate models, including lunar landing vehicle; first manned flight in APOLLO program set for late 1966; advanced version able to orbit 30 tons under consideration. Booster for VOYAGER with CENTAUR upper stage.

SATURN V (ADVANCED SATURN) (NASA)
Systems engineering, assembly and guidance, Marshall Space Flight Center; S-IC stage, Boeing; S-II, North American; S-IVB, Douglas; F-1 engine, North American; J-2, North American. DESCRIPTION: S-IC, five F-1 engines; S-11, five J-2 engines; S-IVB, J2 engine; 140-ton payload in 105-mi. orbit; 95,000 lbs. to escape velocity; 30 tons for planetary missions. STATUS: R&D; first flight scheduled for 1967; prime booster for APOLLO missions; will be used to boost orbiting space station.

SCOUT (NASA)
LTV Aerospace Corp., prime; Honeywell, guidance; Aerojet/Thiokol/Allegany Ballistic Laboratory, propulsion. DESCRIPTION: Solid propulsion four-stage satellite launcher; 72 ft. long; 3.3 ft. dia.; 240-lb. payload in 345-mi. orbit; 80 lbs. to escape. STATUS: Operational; used by NASA for EXPLORER and other small payloads; also procured by NASA for Air Force as BLUE SCOUT; NASA has ordered 23 more boosters.

THOR-ABLE STAR (Air Force)
Douglas, prime; Bell Telephone Labs, guidance; Rocketdyne, first-stage propulsion; Space-General, second; DESCRIPTION: Two-stage vehicle with 181,900 lbs. total thrust; performance, 900 lbs. in 100-n.-mi. orbit; length, 55.9 ft., diameter, 8 ft., weight, 118,200 lbs., height, 79 ft.; guidance, radio command; STATUS: Operational; used in TRANSIT, GEOS and other military programs.

THOR-AGENA D (Air Force and NASA)
No prime; Douglas, THOR frame; Lockheed, AGENA D; Rocketdyne, propulsion. DESCRIPTION: Liquid-propulsion vehicle to put 1,600-lb. payload in 300-mi. orbit; length, 76 ft.; diameter, 8 ft.; launch weight, 123,000 lbs.; 172,000 lbs. thrust; THOR, radio guidance, AGENA, all-inertial. STATUS: Operational; used in AF space program, TELSTAR, Topside Sounder and other NASA programs; NASA has 11 launches scheduled.

THRUST-AUGMENTED DELTA (NASA)
Douglas, prime; Thiokol, solid propulsion. DESCRIPTION: DELTA launch vehicle with three strap-on solids; performance, 1,000 lbs. to Earth orbit; 150 lbs. to escape; propulsion, three XM-33 solid motors producing 55,000 lbs. thrust each. STATUS: Development; to be used for BIOSATELLITE, PIONEER, SYNCOM, TIROS, COMSAT programs; initial flight Aug. 19, 1964, successful.

THRUST-AUGMENTED THOR (Air Force/NASA)
No prime; Rocketdyne and Thiokol, propulsion. DESCRIPTION: THOR-AGENA with 3 strap-on solids; THOR liquid propulsion, 172,000 lbs. of thrust; each strap-on, 55,000 lbs. thrust; performance, 2,500 lbs. in 100-n.mi. orbit. STATUS: Operational; used for NIMBUS, POGO and other payloads too heavy for THOR, but not heavy enough for ATLAS.

TITAN II (GLV) (NASA)
Aerospace Corp., systems engineering & technical direction; Martin, prime. DESCRIPTION: Manned space booster; Essentially TITAN II with addition of redundant electrical power and flight control systems, malfunction detection system and radio command guidance. STATUS: Development; GT-2 (unmanned version) launched Jan. 19; GT-3 successful on March 23; GT-4, June 3, and GT-5, Aug 21, also successful.

TITAN III (Air Force Program 624A)
Aerospace Corp., systems engineering & technical direction; Martin, systems integration; United Technology, large solid boosters; Martin, TITAN II portion; Aerojet-General, liquid engines (Transtage); Martin, standardized upper stage; AC Spark Plug, guidance. DESCRIPTION: Quick-reaction vehicle for military space missions; will be used to boost MOL/GEMINI X; Zero stage, two 120-in. solid motors; first and second stages, TITAN II (storable propellants); third-stage standardized

vehicle to be developed; modified TITAN II guidance; payload, 25,000 lbs. in 100-n.mi. orbit, 2,100 to 22,300-mi. orbit; 5,000 lbs. to escape; STATUS: Development; first flight Sept. 1, 1964 (T-IIIA) achieved primary and secondary objectives, but failed to achieve orbit; second flight (T-IIIA) successful Dec. 10, 1964; first full TITAN III-C flight successful June 18, 1965; 16 or 17 development flights planned; four TITAN II core vehicles (A version), 12 or 13 full TITAN III's (C version); eight or more other satellite payloads have been approved for launch during flight test program; development stretchout moves operational date to June, 1967; an unmanned rated version—TITAN III-X—being studied as more cost/effective booster for satellite launches; uses first two TITAN III-A stages and an AGENA upper stage; first launch, mid-1966. Twenty-four vehicles planned as initial buy.

missiles

ADVANCED SURFACE MISSILE SYSTEM (Navy)
Raytheon, Boeing, Sperry Rand, General Electric, Westinghouse, RCA & Hughes, pre-program definition contracts. DESCRIPTION: Fleet air-defense weapon for the 1970 time period; to have capability against aircraft and certain types of air-to-surface missiles; will replace the 3-T systems currently in the fleet. STATUS: Pre-program definition; program definition planned in mid-1965 and development contract by 1966; $12 million requested in FY 1966 to complete PDP phase; 150-man evaluation group disbanded, program still faces uncertainties.

ALFA (RUR-4) (Navy)
Navy, prime; Avco, frame; Naval Propellant Plant, propulsion. DESCRIPTION: ASW, surface-to-underwater; weight, 500 lbs.; solid propulsion; H.E. depth charge; range, 1,000 yds.; guidance, free-flight. STATUS: Operational; deployed on destroyers and cruisers; being replaced by ASROC.

ANTI-SATELLITE WEAPON (Army/Air Force)
Boeing, AF program; Hughes, terminal guidance (IR), AF program; Douglas, THOR and ZEUS vehicles and support services; A. D. Little, operations analysis. DESCRIPTION: Consists of both NIKE-ZEUS and THOR-AGENA w/terminal stage programs; intercepts have been accomplished at "hundreds of miles," according to Secretary McNamara. STATUS: Operational according to DOD; however, major portions of the AF program are uncompleted at the Johnston Island test site. RFPs for a follow-on were to have been issued in December, 1964.

ARM I (Navy)
No contractor announced. DESCRIPTION: Longer-range, smaller anti-radiation missile than SHRIKE for armament of F-111B and A-7A aircraft. STATUS: Advanced development.

ASROC (RUR-5A) (Navy)
Honeywell, prime; Sangamo Electric, sonar; GE, torpedo; Librascope-General Precision, fire control. DESCRIPTION: ASW, surface-to-underwater; weight, 1,000 lbs.; solid propulsion; warhead, nuclear or conventional torpedo; range between 1,800 yds. and 8 mi.; guidance, unguided. STATUS: Operational on DE, DD, DLG, & heavy cruisers; one "live" weapon fired in 1962 Pacific nuclear tests; extended-range version in pre-program definition phase; version adaptable to TERRIER launchers being developed. FY 1966 procurement to complete Navy's stock needs.

BOMARC A (AIM-10A) (Air Force)
Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion. DESCRIPTION: Surface-to-air interceptor; weight, 15,000 lbs.; liquid booster/ramjet propulsion; warhead, nuclear; range, 200 n.mi.; guidance, command via SAGE; speed, Mach 2.5; ceiling, over 68,000 ft. STATUS: All A missiles at five bases operational in northeastern U.S. phased out by the end of FY 1965; production completed; costs $20 million per year to operate system.

BOMARC B (AIM-10B) (Air Force)
Boeing, prime; General Precision Aerospace/Westinghouse/IBM, guidance; Thiokol/Marquardt, propulsion. DESCRIPTION: Surface-to-air; weight, 16,000 lbs.; solid booster/ramjet propulsion; warhead, nuclear; range, more than 400 n.mi.; guidance, command via SAGE; speed, Mach 2.7. STATUS: Three bases operational; production completed; the 188 B models will be distributed among the eight bases after the A model is phased out.

BULLPUP (AGM-12 B & C) (Navy-Air Force)
Martin, systems cognizance; Maxson Electronics Co., production; AMF, liquid engine; Thiokol, solid propulsion; Naval Propellant Plant, solid propulsion (motor loading). DESCRIPTION: Air-to-surface; range, 3-6 mi.; guidance (visual reference), radio-link command. BULLPUP A: Solid propulsion; warhead, 250-lb. H.E. BULLPUP B: pre-packaged liquid motor; warhead, 1,000-lb. H.E. STATUS: BULLPUP A deployed with Atlantic and Pacific Fleets; operational with U.S. Air Force & NATO units; training version (ATM-12) being procured by both services; being produced in Europe for NATO. Planned procurement of BULLPUP B cancelled in FY 1966.

CHAPARRAL (Army)
A surface-to-air adaptation of the Navy's air-to-air SIDEWINDER. Mounted on vehicles, in a 4- or 6-missile configuration. Philco's Aeronutronic Div. awarded contract for design, development, fabrication and testing of a CHAPARRAL system. CHAPARRAL will be an interim solution to forward-area air defense. (See: SIDEWINDER.)

CLOSE-SUPPORT ASSAULT WEAPON (Navy)
Navy Bureau of Weapons and Johns Hopkins Applied Physics Lab, prime; United Aircraft Norden Div., guidance. DESCRIPTION: Ship-to-shore; outside dimensions compatible with TERRIER shipboard installations; solid propulsion; warhead, high explosive; range, 30 mi. minimum; guidance, inertial and terminal. STATUS: Carried as a line item in FY '66 budget; gyro packages for flight test delivered by Norden; funding dependent on results of guidance system flight tests at WSMR aboard SERGEANT missiles in July.

CONDOR (AGM-53) (Navy)
In-house project, Naval Ordnance Test Station; North American Aviation, Columbus Div. and Northrop Norair Div. awarded PDP studies. DESCRIPTION: Air-to-surface; configuration classified, Range, 40 mi. STATUS: Development; intended for use with Navy version of F-111 and on A-6 Aircraft.

DAVY CROCKETT (M-388) (Army)
In-house project directed by Army Weapons Command at Rock Island, Ill. DESCRIPTION: Surface-to-surface; solid propulsion, bazooka-launched; warhead, sub-kiloton nuclear; guidance, free flight; two launchers — vehicle-mounted or carried by two men. STATUS: Operational in Europe; $13 million provided in FY '64 budget; three per ROAD battalion; seen as defensive rather than offensive weapon to prevent overrun of Europe.

ENTAC (MGM-32) (Army)
Nord Aviation, prime. DESCRIPTION: Anti-tank; weight, 37 lbs. with launcher; solid propulsion; warhead, shaped-charge H.E.; range, 6,600 ft.; guidance, wire-guided; man-portable. STATUS: Operational; procurement complete; will be replaced by TOW.

FALCON (AIM-4A, C, E, F/26A/47A) (Air Force)
Hughes, prime; Hughes, guidance; Thiokol, AIM-4/26 propulsion; Lockheed Propulsion, AIM-47 propulsion. DESCRIPTION: Air-to-air; weight (AIM-4/47), more than 100 lbs. — (AIM-26), more than 200 lbs.; range 5 n.mi.; supersonic; solid propulsion; warhead, H.E. (except for AIM-26B, which carries nuclear warhead); AIM-4A, and 4E, active radar homing guidance; AIM-4C, and 4F, IR homing; AIM-26 model has nuclear warhead and hybrid IR radar homing. STATUS: Operational buy-out of 4E, 4F and 26 in FY '62; AIM-47 is the armament for YF-12A (A-11); several versions operational on F-101, F-102 and F-106.

GENIE (AIR-2A) (Air Force)
Douglas, prime; Aerojet-General, propulsion. DESCRIPTION: Air-to-air; weight 800 lbs.; unguided; solid propulsion; warhead, nuclear; range, 6 n.mi.; guidance, free flight; supersonic; proximity fuzing. STATUS: Procurement complete; operational on F-101B and F-106; improved version cancelled. Launcher being developed by McDonnell for adaptation to F-4 aircraft.

HAWK (MIM-23A) (Army)
Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion. DESCRIPTION: Surface-to-air; weight, 1,275 lbs.; solid propulsion; warhead, H.E.; range, 22 mi.; guidance, semiactive radar homing; 100-45,000-ft. ceiling; provides defense against medium and low-flying aircraft and cruise-type missiles. STATUS: Operational, deployed in Europe, Panama, Okinawa, South Viet Nam, U.S. (13 battalions); bought by Sweden and Israel; R&D being conducted to adapt selected HAWK units to an anti-tactical ballistic missile; NATO producing; Japan also plans buy; $34 million requested for equipment and $8 million for spares in FY '66; no further procurement in FY '66; $11 million improvement program aimed at limited anti-missile capability.

HIBEX (ARPA/Army)
Boeing, prime; Hercules and Aerojet, propulsion. DESCRIPTION: Experimental program in high-energy propellants; cone-shaped missile; performance classified; solid propulsion. STATUS: Development; accelerations of 800 to 1,000 g's goal; static test of motor successful, Nov. 1964; flight test program of 10 vehicles being conducted at WSMR; second successful flight test, May '65, at WSMR.

HONEST JOHN (MGR-1) (Army)
Douglas/Emerson Electric, prime; Hercules, propulsion. DESCRIPTION: Surface-to-surface; weight, 5,900 lbs.; single-stage solid propulsion; warhead, nuclear; range, 12 mi. (M-31), 20 mi. (M-50); unguided. STATUS: Operational; M-50 being deployed in Europe; to be replaced by LANCE; procurement complete.

HORNET (ZAGM-64A) (Air Force)
(Formerly known as ATGAR). Concept based on North American Aviation Columbus Div. unsolicited proposal, funded by AF. DESCRIPTION: Air-launched, anti-tank weapon, electro-optical guidance. STATUS: Pre-development, AF procuring missiles for test at Eglin AFB.

HOUND DOG (AGM-28) (Air Force)
North American, prime; Autonetics, guidance; Pratt & Whitney, propulsion. DESCRIPTION: Air-breathing air-to-surface standoff missile; weight, 9,600 lbs.; turbojet propulsion; warhead, nuclear; range, about 600 n.mi.; guidance, all-inertial; ceiling in excess of 50,000 ft.; Mach 2+. STATUS: Operational; to be launched from B-52G intercontinental bombers; procurement complete.

LANCE (XMGM-52) (Army)
LTV Aerospace, prime; Systron-Donner, guidance. DESCRIPTION: Highly mobile general-purpose missile; very light weight; pre-packaged storable liquid propellant; warhead, nuclear and H.E.; range, 3-30 mi.; guidance, Automet inertial, one missile per launcher. STATUS: Large-scale development. Sixth flight test, Aug. 18, '65, from operational launcher; production decision depends on success of current flight tests; eventually will replace HONEST JOHN and LACROSSE and perhaps LITTLE JOHN; division support weapon; to use multi-system test equipment.

LITTLE JOHN (MGR-3) (Army)
Emerson Electric, prime; Hercules Powder, propulsion. DESCRIPTION: Surface-to-surface; weight, 800 lbs.; solid propulsion; warhead, nuclear; range, 10 mi.; unguided; supplements medium and heavy artillery in airborne divisions and air-transportable commands. STATUS: Two battalions activated in 1961; each equipped with four launchers; air- and helicopter-transportable; may be replaced by LANCE.

MACE (MGM-13A, CGM-13B) (Air Force)
Martin, prime; Goodyear/AC Spark Plug, guidance, Thiokol/Allison, propulsion. DESCRIPTION: Air-breathing surface-to-surface; weight, 18,000 lbs.; turbojet and solid propulsion; warhead, nuclear and H.E.; range, over 650 n.mi. (Model A), over 1,200 n.mi. (Model B); guidance, map-matching (A), Inertial (B). STATUS: Five MACE-A and one MACE-B squadrons (in hard sites) deployed in Europe; two MACE-B squadrons on Okinawa in hard sites.

MAW (Army)
McDonnell Aircraft Corp. and Army Missile Command, development of competitive approaches to Medium Anti-Tank/Assault Weapon requirement; Ford Instrument Co., gyro package for Army version. DESCRIPTION: Surface-to-surface; solid propellant; range, 500-1,500 yds.; shoulder-fired; McDonnell version wire-guided; Army version two-degree-of-freedom, free rotor gyro. STATUS: Exploratory development; competitive approaches have been fired against each other, using a ZUNI test vehicle; the best system will be allowed to proceed into full-scale development when evaluation is complete.

MINUTEMAN (LGM-30) (Air Force)
TRW Systems Group, systems engineering and technical direction; Boeing, major contractor; Autonetics, guidance, Thiokol, first-stage propulsion; Aerojet, second-stage propulsion; Hercules, third-stage propulsion; Avco, re-entry vehicle; GE, MARK 12 re-entry vehicle, MINUTEMAN II. DESCRIPTION: 2nd-generation ICBM; weight, over 65,000 lbs.; solid propulsion; warhead, nuclear; 3 stages; range, over 5,000 mi.; guidance, all-inertial, target selected in seconds; 32-sec. reaction time. STATUS: MINUTEMAN II flight-test program (36 shots planned) began Sept. 24, 1964; 800 MINUTEMAN I's now operational; 1,000 missiles through FY '65; advanced version can be fired by airborne command posts; deployed in hardened and dispersed silos; MINUTEMAN II expected operational 1965; all MINUTEMAN I missiles to be replaced by MINUTEMAN II in phased replacement program costing $1 billion and beginning in 1966; some of the II's replace earlier models; MMII has greater accuracy (nearly 8 times more) and range/payload than I version; nine successful MINUTEMAN II launches now completed, with most recent launch Aug. 23, 1965.

NIKE-HERCULES (MIM-14B) (Army)
Western Electric, prime; Western Electric, guidance; Hercules and Thiokol, propulsion; Douglas, airframe. DESCRIPTION: Surface-to-air, antiaircraft, tactical; weight, 10,000 lbs.; solid propulsion; warhead, nuclear or H.E.; range, 75 mi.; guidance, command; Mach 3+; ceiling in excess of 150,000 ft. STATUS: Over 80 batteries deployed in U.S. being turned over to National Guard; over 10 N-H batteries deployed overseas; Japan plans additional procurement; being equipped with HIPAR, a high-power acquisition radar, and antitactical-ballistic-missile capabilities. Re-location of some HERCULES batteries under consideration by JCS.

NIKE-X/Zeus (XLIM-49) (Army)
Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, propulsion; Douglas, airframe. DESCRIPTION: Antimissile missile, 3-stage; weight, 22,800 lbs.; solid propulsion; warhead, nuclear; range, 200-mi.; guidance, command; length, 48 ft.; diameter, 36 in.; fin span, 10 ft. STATUS: Missile is now part of NIKE-X missile "mix"; development, except as part of X, has ended; no intercept "failure" in more than a year of tests; $10 million requested for preliminary production engineering in FY 1966.

NIKE-X (Army)
Western Electric, prime; Bell Telephone, guidance; Thiokol, ZEUS propulsion; Douglas, ZEUS airframe; Martin Marietta, SPRINT missile prime; Hercules and Lockheed, SPRINT propulsion. DESCRIPTION: Successor to ZEUS as an anti-ICBM system; uses a mix of ZEUS/SPRINT missiles and multi-function array radar (MAR). STATUS: Engineering development; funded at $400 million in FY '66 on accelerated development schedule, but deployment still deferred; GE will submit proposals on a hardened NIKE-X system. Tests to be conducted late this year with MAR at WSMR, N.M., could provide basis for deployment decision; deployment cost: $12-20 billion.

PERSHING (MGM-31) (Army)
Martin, prime; Bendix, guidance; Sperry Farragut, fuzing and aiming; Thiokol, propulsion. DESCRIPTION: Surface-to-surface; weight, 10,000 lbs.; two-stage solid propulsion; warhead, nuclear; range, approx. 400 n.mi.; guidance, inertial; transported on FMC M474 tracked vehicles; replaced REDSTONE. STATUS: Flight test program completed; troop firings from Ft. Wingate, N.M., to White Sands being conducted; number of missile-loaded launchers per unit to be increased; West Germany organizing two battalions; first U.S. PERSHING battalion deployed to Germany in April, 1964.

PHOENIX (AIM-54) (Navy)
Hughes Aircraft Co., prime; Rocketdyne, propulsion. DESCRIPTION: Air-to-air missile for use with the F-IIIB fighter aircraft; each aircraft will be able to carry six missiles. Missile control system designated AN/AWG-9; and missile/bomb launcher is MAU-48A. STATUS: Development. First flight test planned in March, 1966. $71 million in FY '66 funds; Phoenix development problems delaying F-IIIB production.

POLARIS (UGM-27 A, B, C) (Navy)
Lockheed, prime; GE/MIT/Hughes/Honeywell/Raytheon, guidance and fire control; Aerojet-General/Hercules, propulsion; Lockheed, re-entry vehicle; Nortronics, checkout; Autonetics/Sperry, SINS; Westinghouse, launching equipment; Vitro, systems engineering coordination and training; Systron-Donner, ignition programming. DESCRIPTION: Underwater- and surface-to-surface; weight, 30,000 lbs.; solid propulsion; warhead, nuclear; range, 1,200 n.mi. (A-1), 1,500 n.mi. (A-2), 2,500 n.mi. (A-3); guidance, all-inertial. STATUS: 19 subs operational each with 16 missiles; A-1 aboard first five submarines; A-2 aboard subs 6-18; A-3, operational in August, 1964, aboard subs 19-41; total of 41 POLARIS subs authorized; deployed in Atlantic and Mediterranean; Pacific deployment began in 1964; British to buy A-3 missiles from U.S. B-3 (now called POSEIDON) ready for program definition with FY '65 funds; designed for twice the accuracy of POLARIS A-3. Lockheed remains POSEIDON prime, has contract for PDP; Raytheon has study contract for guidance electronics.

QUAIL (ADM-20C) (Air Force)
McDonnell, prime; McDonnell, electronics, guidance; GE, propulsion; TRW, Inc., ECM equipment. DESCRIPTION: ECM-carrying decoy, which simulates B-52 bomber, to enemy radar; turbojet powered; range, 250 mi.; guidance, gyroscopic autopilot. STATUS: Deployed at SAC bases; carried by B-52; procurement completed FY '61; advanced version with 400-mi. range has been flight tested.

REDEYE (MIM-43) (Army)
GD/Pomona, prime; Atlantic Research, propulsion. DESCRIPTION: Surface-to-air; weight, 28 lbs.; solid propulsion; warhead conventional; guidance, IR-homing; length, 48 in.; diameter, 2.75 in. STATUS: Production; tests against helicopters and jets at NOTS successful. Procurement begins with reprogrammed FY '65 funds and $67-million FY 1966 request.

REGULUS I (RGM-6) (Navy)
LTV Aerospace Corp., prime; Sperry, guidance; Allison, propulsion. DESCRIPTION: Surface-to-surface; weight, 14,000 lbs.; turbojet and solid propulsion; warhead, nuclear; range, 500 n.mi.; guidance, inertial; speed, about 600 mph; ceiling, approx. 40,000 ft. STATUS: Five REGULUS subs with 17 missiles are operational now; 3 subs (8 missiles) phased out in FY '65.

SAM-D (Formerly AADS-70) (Army)

Hughes/Douglas/FMC, RCA/Beech, competitive component development contracts. DESCRIPTION: Field army ballistic missile defense system, mobile. STATUS: No decision to develop system has been made; Army has named project manager in advance of expected program authorization; component development funded at $5 million in FY '65; additional FY '66 funding expected to provide basis for system definition studies in FY '66.

SERGEANT (MGM-29A) (Army)

Sperry Utah, prime; Sperry, guidance; Thiokol, propulsion. DESCRIPTION: Surface-to-surface; weight, 10,000 lbs.; solid propulsion; warhead, nuclear; range, over 75 n.mi.; guidance, inertial; uses drag brakes. STATUS: Operational procurement complete; deployed in Europe; replacement for CORPORAL; West Germany buying system. $1.9 million requested in FY 1966 for warhead adaptation kits.

SHILLELAGH (MGM-51A) (Army)

Philco Aeronutronic; prime, Picatinny Arsenal/Amoco Chemicals Corp., propulsion; Aeronutronic, guidance. DESCRIPTION: Surface-to-surface; lightweight; solid propulsion; warhead, nuclear or H.E.; guidance, command; vehicle-mounted for use against field fortifications, armor and for close-in support of troops. STATUS: Production. Initial procurement in FY '65; second-source procurement may come in FY '66; to use multi-system test equipment; engineering development stage began in FY '64; to be installed on Gen. Sheridan assault vehicle; also being considered for use on helicopters; Philco has contract to adapt missile to Army's M-60 tank.

SHRIKE (AGM-45A) (Navy)

Naval Ordnance Test Station-China Lake, prime; Texas Instruments, guidance and control; North American Rocketdyne (McGregor), propulsion. DESCRIPTION: Air-to-surface, anti-radar; solid propulsion; guidance, passive radar homing. STATUS: Operational; armament for Navy and Air Force tactical aircraft.

SIDEWINDER I-C (AIM-9D) (Navy, Air Force)

Naval Ordnance Test Station, technical direction; Philco, IR guidance, Motorola, radar guidance; Naval Ammunition Depot, McAllister, motor loading; Rocketdyne (McGregor), propellant. DESCRIPTION: Air-to-air; weight, about 155 lbs.; solid propulsion; warhead, H.E.; range, more than 2 mi. STATUS: 1-A deployed with Navy and Air Force; 1-C version being procured as replacement for 1-A; NATO-built version now in production. (See CHAPARRAL).

SPARROW III-6B (AIM-7E) (Navy)

Raytheon, prime; Raytheon, airframe, control, guidance; Aerojet-General/North American Rocketdyne (McGregor), propulsion; McDonnell/Benrus Watch Co., launcher. DESCRIPTION: Air-to-air; weight, 350 lbs.; solid propulsion; warhead, conventional; range, 5-8 mi.; guidance, semi-active CW homing; Mach 2.5-3; ceiling, over 50,000 ft. STATUS: Earlier models operational with carrier aircraft; SPARROW III-6B prime armament for Phantom II (F-4B) and other high-performance interceptors. SEA SPARROW, a shipboard-launched adaptation being considered by Navy as a point-defense weapon for small vessels; would use 3-in. modified gun mount as launcher. British F-4 buy expected to include SPARROW missiles; U.S. procurement terminates with FY '66 buy.

SPRINT (Army)

Martin-Orlando, prime; Hercules Powder/Lockheed Propulsion Co., propulsion; Bell Telephone Laboratories, guidance. DESCRIPTION: High-acceleration cone-shaped missile for low-altitude interception of ballistic missiles; 4.5-ft. base diameter, 27 ft. long; two-stage; nuclear; missile will be popped out of silo before motor is ignited; to be part of the missile mix in a NIKE-X battery. STATUS: Development; first flight in March, 1965, tested vehicle aerodynamically but without gas-generator pop-up procedure; pop-up tests to prove silo ejection concept and mechanism under way at Martin-Orlando plant; first full flight test (number 3), including pop-up, planned in fall of 1965 from silo being completed at WSMR.

SRAM (Air Force)

No contractors selected. DESCRIPTION: Air-to-surface defense-suppression standoff missile for use with the B-52, B-58, F-111 or the Advanced Manned Strategic Aircraft. STATUS: Development proposals from 12 firms were due Aug. 30, 1965; due to be evaluated by AF; full-scale development to begin early in 1966; AF contracting feasibility tests for LASRM (Low-altitude Supersonic Research Missile), aiming at doubling SRAM's range; Congress cut FY '66 budget request by $30.7 million; development go-ahead not expected until August, 1966.

STANDARDIZED MISSILE (Navy)

No contractors. DESCRIPTION: Fleet air-defense missile to replace TARTAR-TERRIER and give Navy a single missile to perform both missions; longer-range targets would be engaged by adding a booster to the shorter-range weapon; similar to the homing TERRIER now being procured. STATUS: Development; expected to be procured initially in 1967-68.

SUBROC (UUM-44A) (Navy)

Naval Ordnance Laboratory, technical direction; Goodyear, prime; General Precision Aerospace, guidance; Thiokol, propulsion; General Precision Librascope, fire control. DESCRIPTION: Underwater-air-underwater anti-submarine missile depth bomb; solid propulsion; warhead, nuclear; weight, 4,000 lbs.; length, 21 ft.; diameter, 21 in.; range, 25-30 mi.; guidance, inertial. STATUS: Production scheduled for installation in Thresher-class subs; operational evaluation under way; $23 million requested for FY '66 procurement.

SS-10 (Army)

Nord Aviation, prime. DESCRIPTION: Surface-to-surface, primarily anti-tank; weight, 33 lbs.; solid propulsion; warhead, conventional; range, 1,600 yards; wire-guided. STATUS: Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. replacing with ENTAC.

SS-11 (Army)

Nord Aviation, prime. DESCRIPTION: Surface-to-surface anti-tank, also helicopter-to-surface; weight, 63 lbs.; solid propulsion; wire-guided; warhead, conventional; range, 3,800 yds. STATUS: Operational, to be used with airborne units and Army helicopters.

TACTICAL PROBE (Navy)

Bendix, prime: DESCRIPTION: Surface-to-air; multiple, interchangeable payloads for each mission; booster, TERRIER or TALOS from shipboard installations; high-impulse second stage; range, 50-300 mi.; parachute descent. STATUS: Program definition; a new study has been authorized, and is under way, to evolve a cheaper program.

TALOS (RIM-8E) (Navy)

Bendix, prime; Vitro, systems engineering; McDonnell/Hercules Allegany Ballistics Lab., propulsion; Sperry, guidance; GE, launching gear. DESCRIPTION: Ship-to-air; weight, 7,000 lbs.; solid and ramjet propulsion; warhead, nuclear; range, 65 n.mi.; guidance, radar beam riding/semi-active homing; Mach 2.5. STATUS: Operational aboard cruisers Galveston, Little Rock & Oklahoma City and three Albany-class DEG's; Long Beach, nuclear-powered cruiser, has advanced TALOS; "3-T" get-well program increasing reliability; procurement continues in FY '66.

TARTAR (RIM-24B) (Navy)

Vitro, systems coordination engineering; Applied Physics Lab, design and development; GD/Pomona, Aerojet-General, propulsion; Sperry Farragut, fuze (target detection device). DESCRIPTION: Ship-to-air; weight, 1,500 lbs.; solid dual-thrust motor; warhead, conventional; range, 10 n.mi.; guidance, semi-active homing; Mach 2. STATUS: Operational; installed aboard 23 guided missile destroyers and three cruisers equipped with TALOS; get-well program progressing satisfactorily; CVA Kennedy will also have TARTAR.

TERRIER (RIM-2E) (Navy)

Vitro, systems engineering; GD/Pomona, prime; GD/Pomona, guidance section; Sperry, radar; Hercules Allegany Ballistics Laboratory, propulsion; Northern Ordnance, launching gear. DESCRIPTION: Ship-to-air; weight, 3,000 lbs.; 27 ft. long; solid propulsion; warhead, conventional; range 10 n.mi.; guidance, radar beam-riding or homing; Mach 2.5. STATUS: Operational aboard two attack carriers, 6 cruisers, and 12 missile frigates; get-well program progressing satisfactorily.

TITAN II (LGM-25C) (Air Force)

Martin, prime; TRW Systems Group, systems engineering and technical direction; AC Spark Plug, guidance; Aerojet-General, propulsion; GE, re-entry vehicle. DESCRIPTION: ICBM; weight, 330,000 lbs.; N_2O_4 and Aerozine-50 storable fuels; warhead, nuclear; range, over 5,000 mi.; guidance, inertial; 115 ft. long; 2 stages; greatest payload and range of any U.S. ICBM, basic core vehicle for TITAN III booster. STATUS: All 54 missiles operational; one squadron (18 missiles) operational at Davis-Monthan AFB; one (18 missiles) at McConnell AFB and one (18 missiles) at Little Rock AFB.

TMRBM (Air Force)

No contractors announced, but probably would be same team producing the second and third stages of MINUTEMAN II. DESCRIPTION: A transportable mid-range missile to fill the gap left by cancellation of MMRBM; it would use the top two stages of MM II and the MM II guidance system; would weigh more and be less mobile than MMRBM, but could be developed for approximately one-third the cost; reaction time also less than MMRBM's; employment concept much the same as that of the Russian-deployed missiles in Cuba in 1962. STATUS: Study by the Air Force at DDR&E direction; not likely to be developed due to a lack of mission.

TOW (Army)

Hughes, prime. DESCRIPTION: Anti-tank; weight, 160 lbs.; solid propulsion; warhead, H.E.; wire-guided; optically tracked; tube-launched. STATUS: Development; follow-on to ENTAC; firings being conducted at Army Missile Command.

ZUNI (Navy)

Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion. DESCRIPTION: air-to-surface; weight, 107 lbs.; solid propulsion; warhead, conventional; range, 5 n.mi.; unguided; STATUS: Operational; designed for use on jet fighter and attack aircraft.

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HEXCELITE 840® is the only node adhesive ever developed by the industry which makes it possible to utilize the full properties of 2024 alloy honeycomb.

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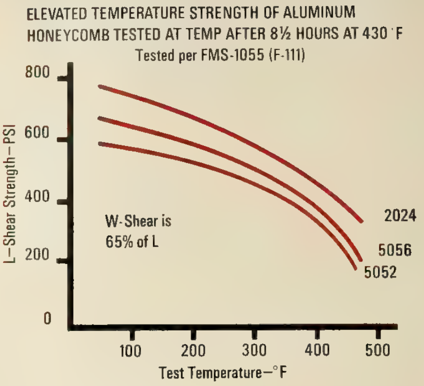

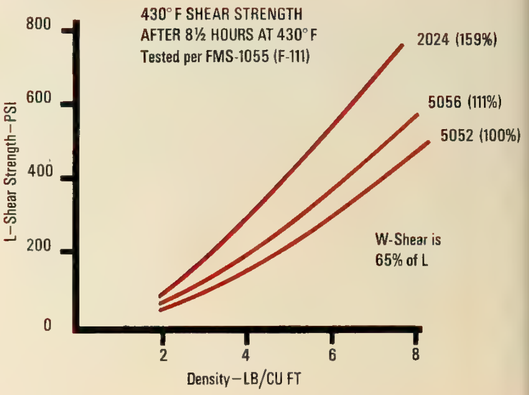

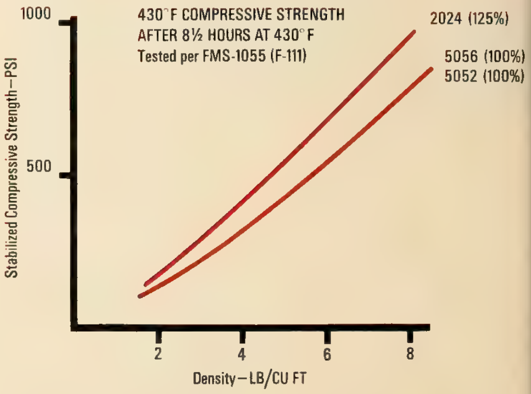

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Circle No. 2 on Subscriber Service Card

Huge Space Simulator Designed

American Optical's Fecker Div. begins fabrication of Ames chamber; spherical air bearing is key to table stability

by Charles D. LaFond

A MASSIVE satellite attitude-control simulator, being developed for installation at NASA's Ames Research Center, Moffett Field, Calif., will closely reproduce environmental conditions for orbital spacecraft, including motion, attitude, altitude, stellar light and Earth influences. Provision will be made to add solar simulation in the future.

Under a $1.1-million contract awarded to the J. W. Fecker Division of American Optical Co. in August, 1964, the 22-ft.-dia. spherical vacuum chamber will be designed to provide a unique stable table, suspended on a spherical air bearing. Unusual in the table design is a technique for introducing electrical energy and reaction-jet gas through the table directly to the equipment under test, thus assuring balance integrity and eliminating the need for adding batteries, pressure tanks or telemetry subsystems.

Basic design and engineering for the big simulator is complete. Fecker is now in the early stages of hardware development and fabrication for the internal equipment. Chicago Bridge and Iron, Inc., is fabricating the vacuum chamber shell and F. J. Stokes-Systems Division of Pennsalt Chemical Corp. will supply vacuum pumps to Fecker.

The vacuum chamber, which will open at the diameter for introduction of simulator equipment and test hardware, will be installed upon its completion at Ames. The other hardware will be calibrated and tested at Fecker's Pittsburgh plant, will be partially disassembled, and shipped to Ames for installation and recalibration in the chamber by July, 1966.

- **Platform design**—The stable table, measuring about 6 ft. in diameter, is to be located in the center of the vacuum chamber. It will be suspended atop the spherical air bearing on a column rising some 10 ft. from the chamber floor.

A follow-up gimbal system is employed about the air bearing sphere to permit positional movement and readout of test platform attitude to ±30° from the horizontal axis and continuous azimuth rotation.

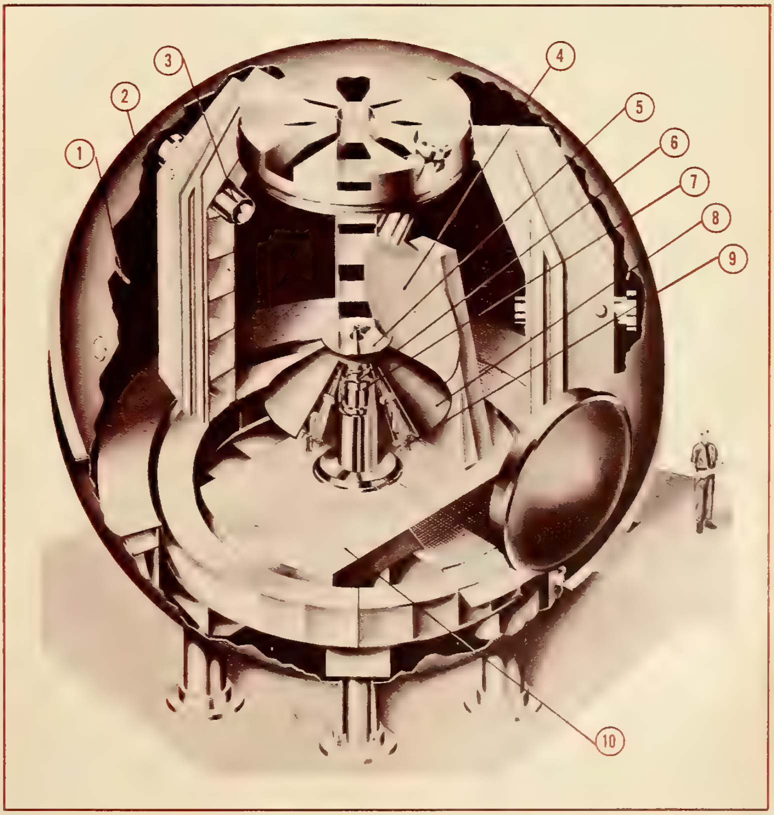
Conical in shape, the test platform is used to simulate both attitude and motion of a satellite through the use of 12 air reaction jets on the platform structure. All the normal motions or attitudes of yaw, pitch, and roll can be simulated.

The basic platform inertia, according to Thomas Reiner, simulator project manager at Fecker, is approximately 100 ft.-lbs./sec.^{2} Satellite inertias of up to 600 ft.-lbs./sec.^{2} in yaw and 350 ft.-lbs./sec.^{2} in pitch and roll can be simulated readily through the addition of weights to a ring that will extend from the main platform support.

After test equipment installation, according to Reiner, the table can be balanced and held to within 100,000 dyne-cm., including all disturbances.

A key element in the platform de-

AMES SIMULATOR consists of 1) Helmholtz coil, 2) vacuum chamber, 3) star simulator, 4) Earth simulator, 5) mounting platform, 6) spherical bearing, 7) gimbal assembly, 8) inertia cones, 9) air thrusters and 10) Earth-simulator drive.



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sign (and one for which a patent application has been filed) is the energy connecting interface between the column and the stable platform. Although details are still being withheld by American Optical, Reiner did indicate that "liquid-conduction" techniques will be employed for electrical energy transfer —both for test equipment power and for the transmission of test data.

The importance of such an approach, believed unique by Fecker engineers for highly accurate test tables, is that table balance is not disturbed by the addition of power of telemetry subsystems.

In addition, the approach permits test operation over extremely long periods of time, since neither the power nor the thrust-gas supplies are limited.

● **Other simulated influences**—An Earth simulator system will be employed that will rotate about the central test platform at a programmed rate. This system will consist of a 6-ft.-dia. circular disc, which is electrically heated to simulate the radiation characteristics of the Earth as seen from a satellite. A computer-programmed drive system will control the varying rates of the Earth simulator about the test platform to simulate all circular and elliptical orbits with periods from 84 min. to one day, at a 10,000-mi. apogee and a 200-mi. perigee.

The basic test facility also includes three variable intensity stellar simulators that can be positioned about the test platform in 15-degree steps from 30° below the horizon to the zenith. The stellar simulators provide 12-in.-dia. star beams, round to within ±5%. The white star beams are adjustable to provide apparent star magnitudes from −2.0 to +6.0 in 0.5-magnitude steps.

The vacuum chamber is designed to provide a simulated space vacuum of 1 torr, even when the air jet system and the air bearing are operating, Fecker engineers say.

The Earth's magnetic field can be effectively eliminated or simulated as seen by the test-platform-mounted satellite package. This will be accomplished in the firm's design by three pairs of Helmholtz coils located about the three orthogonal (yaw, pitch and roll) axes of the test packages. By proper control of the current in each of the three sets of coils, the magnetic field intensity in any point of the experimental package can be adjusted to the desired intensity within 0.5 gauss, developers claim.

The test platform base, Earth simulator and stellar simulators will be supported on a welded aluminum base structure; the structure will rest on six aluminum legs, which will be bolted to a seismic foundation to isolate the system from ground vibrations. The vacuum chamber will provide approximately a 21-ft. inside diameter sphere. The shell will be supported on legs that are separate from the internal simulator support.

The vacuum vessel will have a flanged hatch located diagonally across the horizontal mid-line of the sphere, which permits removal of the upper portion of the vessel for convenient access to the simulator equipment. A personnel access hatch also will be provided, and two 12-in.-dia. ports with blank-off plates will be located in the vessel wall for future incorporation of solar simulators. Finally, four observation ports will be located in the vacuum vessel wall. ■

Deep-Scanning Sonar Developed

AN IMPROVED high-resolution side-looking sonar capable of scanning the ocean bottom to depths of 20,000 ft. in a 2,400-ft. swath has been revealed by Westinghouse Electric Corp. Developed by the firm's Underseas Div. in Baltimore, the new instrument can be designed for use in three versions: submerged and towed, surface ship hull-mounted, and fixed-location mechanical scanning.

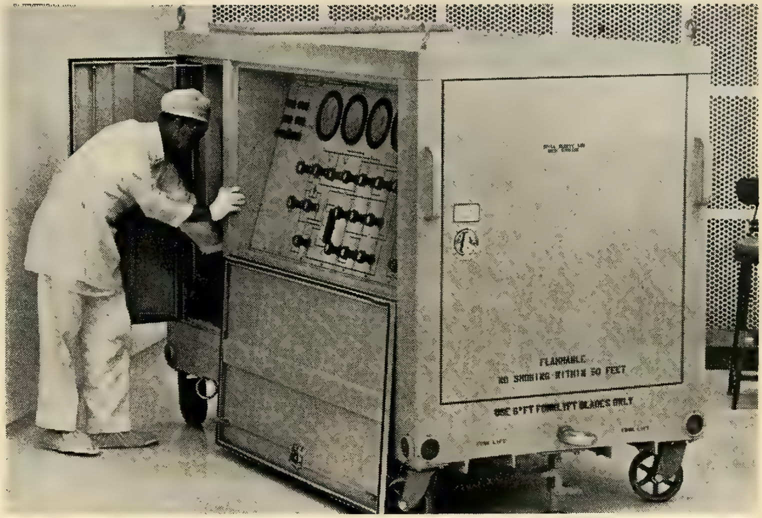
Applications are in geological and biological ocean-bottom searches and surveys, mineral or petroleum prospecting, underwater cable surveys, and bottom topographical studies that will aid in navigation.

In operation, the ocean-bottom scanning sonar transmits acoustic energy pulses (1 millisec. or less) in a fan-shaped pattern by means of acoustic transducer arrays.

Return signals are picked up by receiver acoustic arrays and amplified. Amplitude compression circuits shape the signals to fit the display equipment's input limitations. Simple time-sequential scanning of the return signals modulates the display-input signals, giving a realistic image of the strip of ocean floor that is covered.

To provide a complete picture of a large area of the ocean bottom, sequential images of a number of strips of the bottom are stored by the display and recording equipment. The result is an image or paper facsimile recording of a segment of the ocean bottom, typically a rectangle that may be 0.5 × 1 mi.

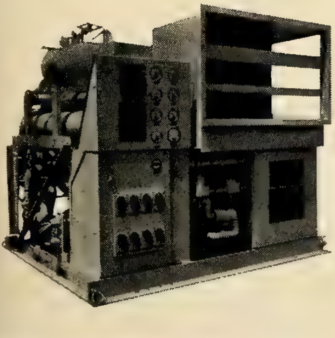
If you need a compact liquid propellant servicing system for a spacecraft, service module or space lab, and you need it in a hurry—call Garrett.



For example, look at the Surveyor spacecraft propellant fill and conditioning system we built for Hughes under contract to the Jet Propulsion Laboratory for NASA.

Not only does it have some exceptional design features, but we completed it weeks ahead of time on a tight delivery schedule.

The system is completely mobile and self-contained. It cleans, flushes and purges the spacecraft's vernier propulsion system, checks out the pneumatic components, and fills the tankage with monomethylhydrazine hydrate fuel and nitrogen tetroxide oxidizer.



With these toxic propellants we need a safe, effective vapor disposal system. So, in keeping with the compactness of the system, we designed small, efficient units and put them inside the carts.

Without any external propellant disposal facilities whatsoever, we keep the toxic vapor level to less than 10 parts per million, which makes it completely safe for operating personnel.

These are the units in the system:

The Control Console checks the pneumatic components of the spacecraft propellant system, and supplies the operating pressure for the servicing and purge carts. It has 3000 and 6000 psig nitrogen channels, and 3000, 6000 and four 800 psig helium channels.

Servicing Carts store propellants, evacuate the spacecraft propellant system, load and offload propellants. Vapor disposal systems are self-contained.

Purge Carts (shown above) flush the spacecraft propellant system with solvent, purge with nitrogen, then evacuate and dry the system. Carts have self-contained vapor disposal systems.

We also make Propellant Thermal Conditioning Systems. The one shown at left is for the propulsion system on the Apollo spacecraft service module.

This compact system provides temperature control for batch-stored propellants, and propellants that are being transferred to the spacecraft.

So, as we said, if you need compact liquid propellant servicing systems for spacecraft, space labs or service modules, or other missile, space and avionics AGE equipment, come to Garrett.

For more information contact AiResearch Manufacturing Division, Product Support Sales, 9851 Sepulveda Boulevard, Los Angeles, California 90009.

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Rocket Research Corp. Expands Market Drive

by John F. Judge

SEATTLE—Rocket Research Corp. is preparing for a major expansion in facilities and production ability in the face of a possible $90-million increase in new business.

The firm expects to invest more than $2 million in buildings and equipment in a move that will consolidate its research, development and production facilities at a site in the Kent Valley area near the huge new Boeing Space Research center.

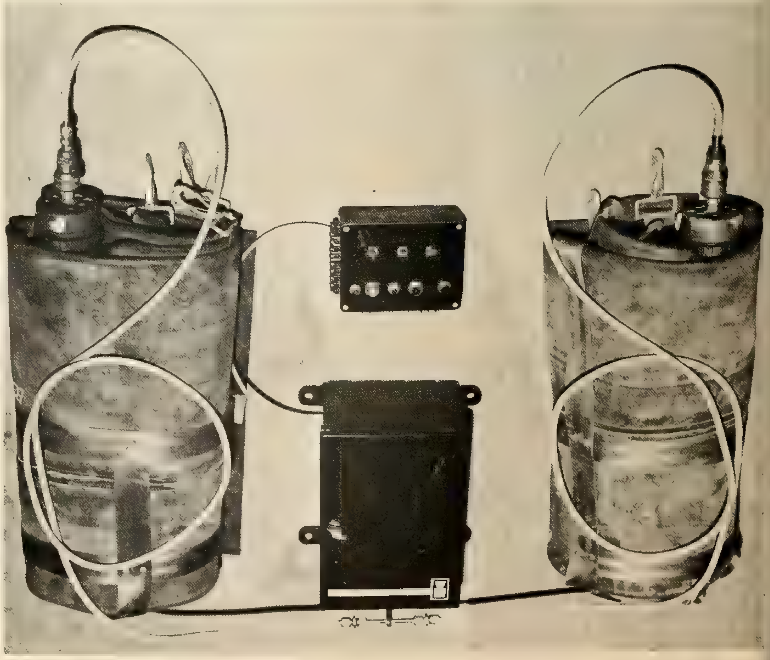
Robert M. Bridgeforth, chairman of the board and chief executive officer of Rocket Research, told MISSILES AND ROCKETS the firm has outstanding proposals requested by both government and industrial customers totaling some $90 million. If only 10% of these develop into solid business, it will triple RRC's total volume since its creation in 1960.

The optimistic outlook of the firm is based on an intensive exploitation of a catalyst that spontaneously decomposes hydrazine. George S. Sutherland, president, said the major percentage of RRC workload is directly related to the application of this new hydrazine technology to control rockets, and a new family of gas generators.

- **New propellant**—Rocket Research has concentrated on small control rockets, using subliming solids, bipropellants and monopropellant hydrazine. In addition, the firm has developed a proprietary high-energy monopropellant called Monex.

Monex is still in the early development stages and represents a family of stable compounds. One form, a medium-energy compound, is said to be competitive in performance with current solid

A 150-LB.-THRUST hydrazine monopropellant thrust chamber assembly. Its overall length, including propellant valve, is 18 in.



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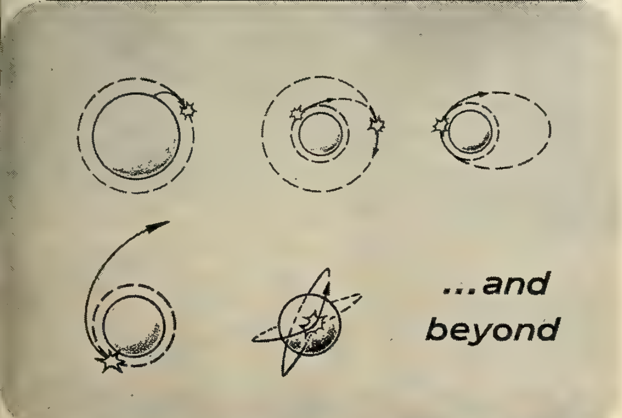

MD 5-7

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FLIGHT MECHANICS — 3-5 years' aerospace experience with B.S. degree and graduate work preferred. Assignments involve technical investigations of trajectory shaping, payloads, sizing, orbit mechanics, staging and launch analysis, penetration aids, stability, guidance concepts and error analysis, and systems integration.

ELECTRONIC SYSTEMS — 3-5 years' experience with B.S. or M.S. degree. Analysis and design of airborne and ground electrical and electronics systems and hardware including tracking, range safety, telemetry, instrumentation, antennaes, digital and solid state circuits.

BASE ELECTRICAL — B.S. in E.E. with 3-5 years' experience involving design of electrical power installations, electrical ground cable and missile interconnecting systems, switching and distribution units. Will develop specifications, test requirements, and analysis of flight data.

GUIDANCE AND CONTROL — B.S. in E.E. or Math with 3-5 years' experience. Assignments involve the ability to prescribe the requirements for advanced flight control and stability studies. Individuals will synthesize and analyze control systems for booster and space vehicles during ascent and in-orbit flight conditions.

STRUCTURAL AND MECHANICAL GROUND BASE DESIGN — Structural mechanical designers to work on missile ground transport and launch equipment. Experienced in fluid systems design, process piping, mechanical component design (valves, regulators, filters) or heating, ventilating, air conditioning equipment.

Layout and design of heavy steel support structure, slings, dollies, hoists, transporting, erection or handling equipment. Missile experience not mandatory. Engineering degree preferred.

STRUCTURAL DYNAMICS — Advanced degree with 5 years' senior technical experience. Performs highly complex aeroelastic, dynamic and/or load analysis or tests on an independent basis. Develop improved math models dynamic response analysis, buffet, gust and flutter.

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OPERATIONS ANALYSIS — Several senior and intermediate level positions requiring 3 to 8 years' proven aerospace experience with demonstrated modeling capability. Assignments will involve development of math models for various aspects of weapon and space systems effectiveness. Analyses will include study of existing and projected weapon and space systems via mission analysis, war-gaming, simulation, estimates of offensive and defensive force size and mixes, payload utilization and customer requirements. Applicants will have a Bachelors Degree and some advanced study.

INTELLIGENCE SPECIALIST — Will conduct critical analyses to establish intelligence parameters, effectiveness tradeoffs, determine impact on strategic offensive-defensive force requirements plus impact on future strategic weapon systems. A degree is important or 10 to 15 years' experience which is current in Stratintell, Data Acquisition, Processing, Sensor Command and Control Systems.

SPACE MISSION ANALYST — With B.S. and advanced work desirable plus 3 to 8 years' experience, will provide mission analyses of national space programs to develop trends for both launch vehicles and spacecrafts utilizing economic and technical knowledge will determine forcing functions and interactions between payload development and launch vehicle growth.

PARAMETRIC COST ANALYSIS — Economic aerospace background will be utilized to determine cost trends in large system development, procurement and operation. With historical data and technological projection, develop cost curves based on system parameters such as payload weight, pounds of vehicle, ballistic ranges, etc., that can be directly applied in cost effectiveness tradeoffs of future military and space systems. Bachelors Degree and 5 to 8 years' experience in cost analysis and economic planning.

COMPUTER PROGRAMMERS — To analyze, develop and implement business data processing applications for large scale tape oriented computer systems. IBM 7000 series experience desirable. Minimum two years' programming experience mandatory. B.A., B.S. or equivalent data processing experience required.

STRESS ANALYSIS — Utilizing computer techniques, will conduct stress analyses of airborne and ground structural and mechanical components involving large booster systems. Will plan and coordinate necessary testing. A B.S. degree and 3-5 years applicable experience is needed.

ACOUSTIC AND VIBRATION ANALYSTS — Graduate engineers, M.E. or E.E., with minimum of two years' experience on analysis and prediction of rocket and missile acoustic and vibration environments, to conduct post-flight studies on large booster systems.

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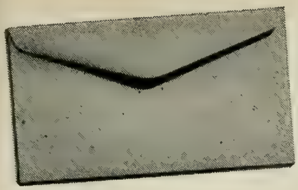

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Electrical Engineers
Automatic Test Systems. Requires experience analyzing design requirements to control product quality.
Structures
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Propulsion Design
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Advanced Propulsion systems
Set preliminary design criteria for solid and liquid systems.
Control Systems Engineers
Design, analysis: Nike-Zeus, Thor.
Ground Support Equipment
Design & test ground support equipment. Design electrical systems.
Chemist/Chemical Engineer
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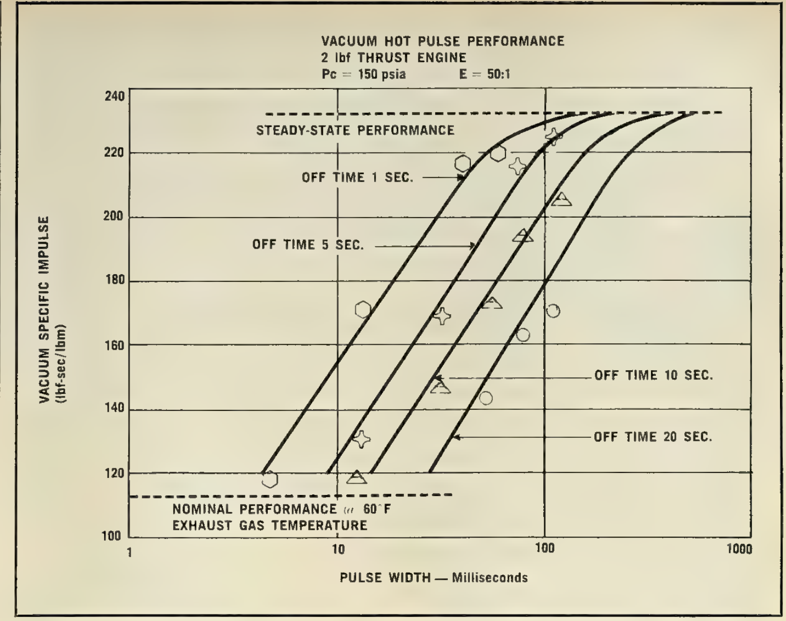
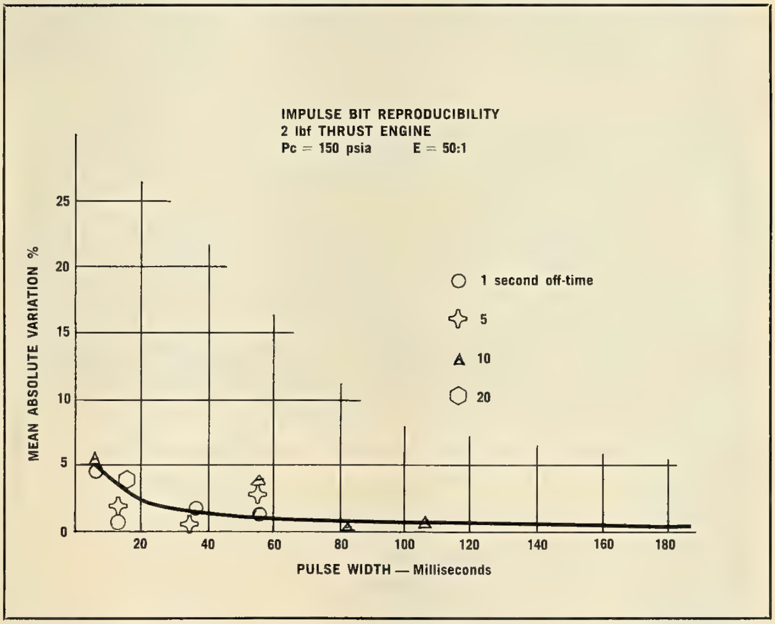
Chemist—Fuel Cells
Applied electrode technology catalysis, or electrochemical technology.
Mathematician
PhD. Help make new, special purpose computers/programs.
Battery Technologists
Design, fabricate, test: High energy density batteries, electrodes, separators, cases, seals, components.



LOW-RANGE values shown are unique with this reaction unit system.

CONDITIONS here were same as those shown in impulse bit reproducibility graph.



formulations, but costs about 13 cents a pound.

As a high-energy liquid monopropellant, Monex provides the basis for a future move into large liquid rockets. Rocket Research intends to design and build large liquid systems—not restricting itself to the role of a propellant supplier.

The high-energy work has led to development of a new explosive. Sutherland says this material is safe and easy to handle, yet has a yield higher than any man-made explosive below the nuclear categories. The explosive can be supplied in either liquid or gelled form and is detonated by standard techniques.

The largest effort at Rocket Research currently centers around the Shell 405 catalyst. Sutherland says development of this catalyst by Shell Development Co. under NASA funding has opened entire new areas for hydrazine monopropellant systems.

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target acquisition,
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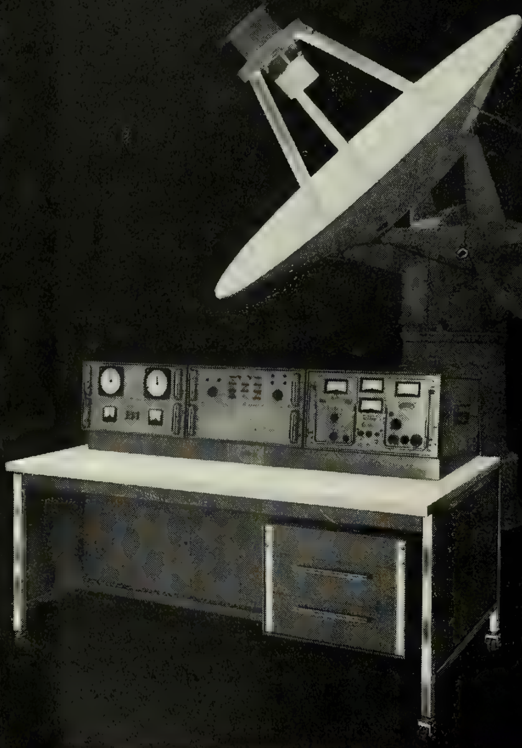
larger primary tracking systems.



This compact, high-performance system offers unusual economy, reliability proven in exhaustive tests and actual range operation, and quick delivery (90 days ARO). It is suitable for ground, mobile, or shipboard installation, and neatly packs these features:

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Rocket Research has adapted the catalyst to new types of reaction-control systems and a complete family of gas generators. A new division of the firm is investigating its potential for underwater use.

Although simple in concept, application of the catalyst to reaction-control systems with maximum performance and reliability is not easy. After more than two years of intensive research, the firm feels it is in an excellent competitive position.

- **Catalyst function**—The catalyst itself is classified, but it is essentially a bed-type and acts as a true catalyst. It initiates and supports the decomposition process. The catalyst will decompose hydrazine down to its freezing point and its degradation time is calculated in hours. For instance, scientists at Rocket Research have operated one bed for a total reaction time of 14 hours with no degradation in the catalytic action of the 405 material.

The spontaneous catalyst permits efficient operation of hydrazine rockets in the pulse mode. In addition, the temperature of the exhaust gases can be controlled.

The operation of a gas generator using the catalyst is essentially the same as a reaction-control thrustor. Rocket Research can select output gas temperatures ranging from 175° to 2,200°F by varying catalyst bed lengths and hydrazine-based propellant mixes.

Since the gas products of hydrazine are ammonia, nitrogen and hydrogen, the exhaust gases are extremely clean. There is no concern with particle contamination, and filter problems are eliminated.

The performance of the 405 catalyzed-hydrazine reaction is basically independent of ambient temperatures. Restarts are readily achieved by opening a valve. The system can be made to operate on a demand basis through simple liquid flow regulation.

In either application—as gas generators or rockets, the decomposition temperature is within the ranges easily handled by standard thrust chamber materials such as stainless steel and Haynes Alloy No. 25. Again, there is essentially no throat and nozzle wear even with these materials.

The molecular weight of the decomposition products is low-giving both good rocket performance and high work-per-unit-weight flow as a gas generator.

- **Product performance**—In the pulsing mode, small rockets developed from the 405 spontaneous catalyst technology have short pulse widths primarily determined by the duty cycle—reactor bed temperature. In comparison, bi-propellant rocket performance exhibits a nonlinear dependence on pulse widths for

ENGINEERS . . . consider your leisure hours as well as your work hours

As a professional engineer, your job is a vitally important aspect of your life. But also important are the hours away from work, when you and your family are free to enjoy your favorite leisure activities. If you decide to work at Pratt & Whitney Aircraft, you will find an abundance of recreational facilities of every variety located nearby.

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During work hours, your knowledge and abilities will be genuinely challenged. Our activities in the aerospace propulsion field demand a high degree of engineering competence and our policy is to offer important responsibility to men as soon as they demonstrate the willingness and the capability to handle it. You will work hard, but you will benefit from excellent salaries and company benefits, unusually good advancement potential and a departmental stability that is unique in the aerospace industry.

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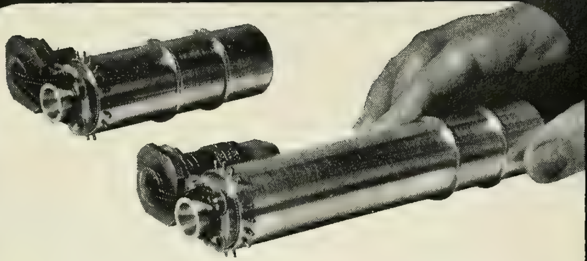

Hercules builds huge rocket motors to put satellites into orbit. We also make smaller ones for other uses. The two types shown above were developed by Hercules to reduce the rotation rate of an orbiting satellite and to reinstate this rotation—on command. Used on "Topsi," the near polar orbiting satellite, the smaller rockets were fired to reduce spin so that the satellite's antennas could be extended. The larger rockets were fired to reinstate spin.

Each rocket developed an average thrust of one-quarter pound. This is only a tiny fraction of the thrust that Hercules® solid propellants gave to the third and fourth stages of the "Topsi" launch vehicle—but no less important to the satellite's success. Whatever the project's size, there are rewarding careers in chemical propulsion at Hercules for those who qualify. Send career inquiries to Manager, Technical Recruitment, Explosives & Chemical Propulsion Department,

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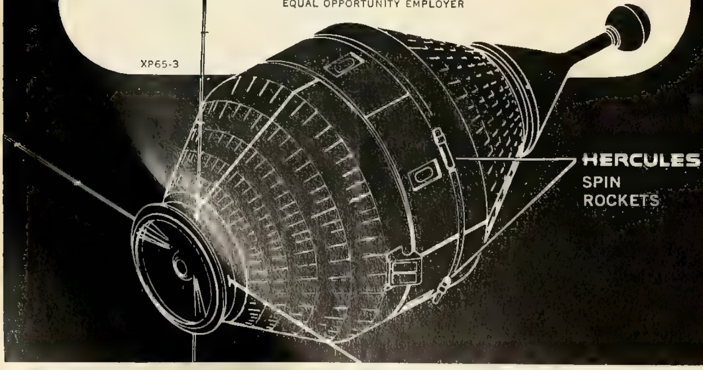

short pulse widths.

In operation as a pulse rocket, the system duty cycle employed at a given pulse width determines the catalyst bed equilibrium temperature. All the hydrazine injected into the catalyst area is decomposed so that performance is essentially determined by the gas outlet temperature. This allows good performance, even at short pulse widths.

Sutherland expects the monopropellant hydrazine systems will eventually replace most current chemical reaction control systems. In many instances, the overall performance is equal to or just below that of a comparable bi-propellant system. Even where performance is lower, the simplicity, reliability, lower temperatures and lack of complex system components must be considered in a mission package. These are available at any thrust level.

Sutherland says the catalyst has been tested and demonstrated to be capable of withstanding the launch environment, extended-duration firings and pulse mode operation exceeding 100,000 pulses without failure or change in performance.

Rocket Research recently completed reactor qualification of the first flight system to use the catalyst. A point emphasized by Sutherland is that hydrazine systems are not new. The only element not previously flown is the spontaneous catalyst.

- **NASA control rockets**—Rocket Research is in the early phases of a contract with NASA aimed at developing designer data for monopropellant rocket control systems.

The first phase will cover testing of injector concepts and various injector design parameters within each concept. The objective is to arrive at an optimum injector, and then develop pertinent injector performance factors.

The second phase concerns the effect of catalyst particle size on reactor operation. In general, as smaller catalyst particles are employed at lower thrust levels, particle size is selected as a function of the reaction mechanism. But the distribution of the hydrazine through the catalyst in its operation is important. The objective is to arrive at the optimum particle size for each thrust level.

The third phase combines the results of the first two steps and covers studies at chamber pressures from 50 to 1,000 psi, varying catalyst bed lengths and studies of the effect of catalyst bed loading.

The overall program is technically directed by NASA's Jet Propulsion Laboratory and includes thrustor firings at the 0.5-, 5- and 50-lb. levels. The result will be the design and firing of a 100-lb.-thrust unit using all the information gleaned from the earlier phases of the program.

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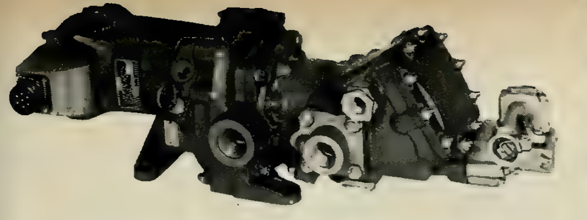
Circle No. 16 on Subscriber Service Card—

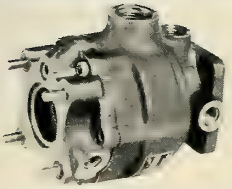


Motorpumps, including integral gearboxes when required, for secondary power applications on aircraft and missiles combine reliability with light weight.

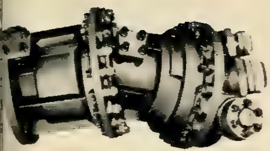
Auxiliary power units for primary and secondary fluid power systems are available in modular and completely integrated designs.

gas motorpumps operate on bi-
ellants and solid propellants for
ary and secondary control power in
iles and space vehicles.

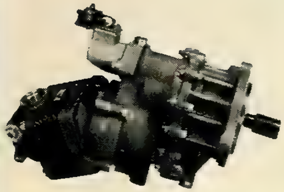
LOOKING FOR PROVED FLUID POWER AND CONTROL?



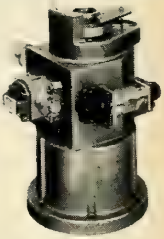
Vane-type fuel pumps offer high efficiency, high output and speed capability, significant weight reduction and meet severe contaminant tolerance specifications.



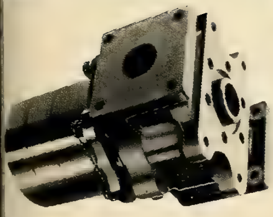
High temperature pumps like this are
now operating on mineral-base fluid at
450°-550° fluid temperature and 3000 psi
utlet pressure. Feasibility studies have
een completed on pumps for future
ystems to 1200°F.



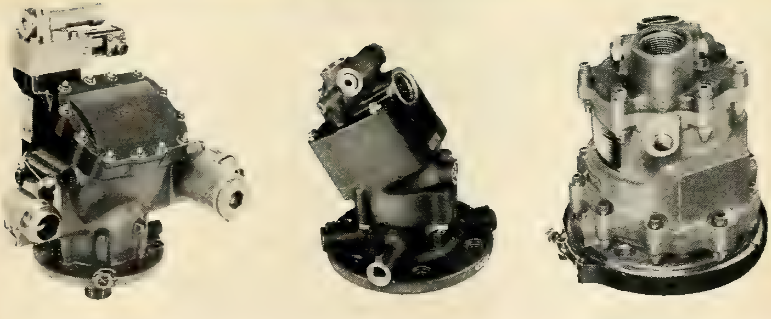
Compact, hydraulic starters perform repeated starting cycles and permit motoring of engine for extended periods. Also provide hydraulic pumping mode during flight.



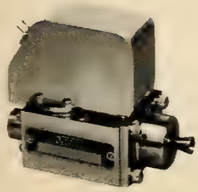
Servo-actuators, like this one for rapid tuning of microwave transmitters, handle a wide range of precise positioning tasks.



Single-stage, hot gas pressure regulating valve that controls combustion pressure of solid propellant gas generator is typical of complete line.



Yoke-type, fixed-angle and in-line variable displacement pumps combine millions of hours of inflight operation, let you choose the best pump for the application.



Pulse modulated rocket motor delivers to 6 pounds of thrust, requires 8 to 10 times less power input than previous state of the art.

For more details on these and many more applications, write for Bulletin A-5283A "Harnessing Fluids for Airborne Uses." Vickers Incorporated, P.O. Box 302, Troy, Michigan 48084.

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- **Underwater potential**—The extreme flexibility of the hydrazine/Shell catalyst technology is illustrated in the budding underwater department at RRC. Besides the obvious military applications in torpedoes and other submersible weaponry, there are several potential commercial areas of application.

The gas generators, based on the catalytic method, are independent of certain ambient conditions and can be designed to function at extreme depths. These can be developed as propulsion devices over a range to include large manned submersible, sleds and individual swimmers.

In addition, the gas generator approach could be the basis for a whole series of underwater bouyancy devices. Oceanographic probes are getting more and more costly, and loss at sea can become a prohibitive cost factor.

Hydrazine-powered gas generators connected to collapsed flotation gear and attached to such equipment could easily form a major market for RRC. Other bouyancy devices could be designed to lift and recover heavy items from the sea bottom at various depths.

The ability to stop and restart the hydrazine/catalyzed gas generators means an ability to bring large masses up on an even keel with as many stops as needed to do the job.

- **Salvage work**—The firm recently completed the inital demonstration tests of a new underwater recovery system. Designated Project RISE—Re-usable Inflatable Salvage Equipment—the tests were carried out on Puget Sound near Seattle in 30 ft. of water.

A small 16-ft. cabin cruiser, ballasted to overcome its buoyancy, was pumped full of sea water and sunk at the test site. The flotation bags were collapsed and carried to the bottom by a diver. After the bags were installed on the sunken cruiser, the diver carried the small gas generator and its associated quick-disconnect gas hoses down to the craft and hooked them to the bags.

The bouyant recovery apparatus—Buoy-Pak—consists of two fabric-reinforced rubber flotation bags of approximately 500 lbs. displacement each, and a monopropellant gas generator.

The equipment used in the tests was identical in principle to that tested by the U. S. Navy in deep-submergence torpedo recovery demonstrations at San Clemente Island in December 1964. These involved tests at depths of 1,000 ft. using the French diving saucer, Souscoupe.

Additional Buoy-Pak tests are planned in the continental shelf depths in Puget Sound. Rocket Research has completed preliminary designs of systems capable of operating at ocean depths in excess of 20,000 ft. and providing buoyant forces up to 80 tons. ■

only a beginning . . .

MISSILES AND ROCKETS will publish its Fifth Annual NASA Issue November 29, 1965. This issue, now accepted as the authoritative annual publication on the nation's space agency, will examine the National Aeronautics and Space Administration's current and future projects and facilities.

After a year of spectacular achievement, including Astronaut White's record extravehicular space walk, NASA is looking ahead to its new space programs. Special emphasis is placed in this issue on the earth orbit, lunar orbit and lunar landing missions, which have an estimated total cost of over $1 billion and project Voyager, which will explore Mars, Venus and other planets.

This special issue will also explore NASA's plans for other projects as the U.S. space program begins its swing away from the exploration of the Moon to the vaster and more challenging mission of probing the planets..

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By request, the Fifth Annual NASA Issue of MISSILES AND ROCKETS will provide 5,000 bonus circulation to the decision-makers in NASA, AEC and ComSat Corp. This means more impact, more readership for your advertising dollars in MISSILES AND ROCKETS.

Publication Date: November 29, 1965 **Closing Date: November 15, 1965**

MISSILES AND ROCKETS, 1001 Vermont Avenue, N.W., Washington, D. C. 20005

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Or would you use beryllium or titanium?

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The Industry Week

Martin Company Cited for Space Work

The Small Business Administration last week commended the Martin Co. for its "leadership in promoting growth and welfare of hundreds of small firms through utilization of their facilities and skills in the production of the Gemini-Titan space boosters." Martin and 11 of its subcontractors were presented with special aerospace awards by the SBA. Named with Martin were: Captive Seal Corp., Caldwell, N.J.; Epsco, Inc., Westwood, Mass.; Littlefuse, Inc., Des Plaines, Ill.; Francis Associates Co., Denver; Rosemount Engineering Co., Minneapolis; Kinetics Corp., Solana Beach, Calif.; Autronics Corp., Pasadena, Calif.; Hi-Shear Corp., Torrance, Calif.; Hydra-Electric, Inc., Burbank, Calif.; Leach Corp., Los Angeles; and Sterer Engineering & Manufacturing Co., Los Angeles. The 11 firms were chosen by Martin as best representing the traits of resourcefulness and reliability it seeks in subcontractors. Martin was recently also presented the Armed Forces Management Association's service award for "outstanding accomplishment in the field of professional management" in its contributions to the Zero Defects Program, created at Martin three years ago and since implemented by the military services, and adopted by more than 1,000 other firms.

Mergers and Acquisitions

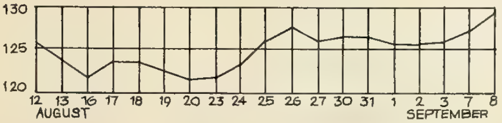
Page Communications Engineers, Inc., Washington, D.C., has given division status to its Astro Technology subsidiary of Mountain View, Calif. Astro Technology specializes in tracking, telemetry, and command techniques and devices and is in the process of expanding its capabilities in the areas of data acquisition and timing and control equipment. It is also diversifying into medical electronics and underwater communication and instrumentation. The new status will make available to Astro Technology Page's technical resources and experience. . . . *The Ohio Steel Foundry Co., Lima, Ohio, has acquired h nu systems, inc., of Palo Alto, Calif., from Energy Systems, Inc. The move is said to be the first step in a planned diversification program by Ohio Steel.* . . . Metallurgical Service Laboratories of Santa Fe Springs, Calif., has absorbed Spectro Laboratories, Los Angeles. Aim of the merger is the broadening of MSL's capabilities in analytical metallurgical chemistry. Spectro will continue operations in Huntington Park, Calif., until laboratory facilities in Santa Fe Springs are expanded to permit its relocation. . . . *Tyco Laboratories, Inc., Waltham, Mass., has entered a contract to acquire Custom Metal Products, Inc., of New Hyde Park, N.Y. Tyco conducts research in the fields of solid-state electronics, electrochemical science and metallurgy. Custom Metal makes precision metal parts and components for use primarily in the electronics industry.* . . . Edison Instruments, Inc., Rahway, N.J., has purchased the patent estate of the bankrupt firm of International Ultrasonics, Inc., including all patents, trademarks and the International Ultrasonics name. The patents are said to include several on ultrasonic welding of plastics and ultrasonic transducers. Edison plans to activate an Internations Ultrasonics Division to be concerned primarily with ultrasonic plastic welding equipment and service.

New Activities

Aerojet-General Corp., Sacramenta, Calif., has established the Aerometrics Div. to manufacture and sell advanced space-age products for industrial and commercial uses. Initial products will include pressure and temperature-sensing devices and flow and speed measuring equipment. Division manager will be R. H. Dow. . . . *Weston-Boonshaft and Fuchs Div. of Weston Instruments, Inc., Hatboro, Pa., has established a Waveform Analysis Center. The center will provide RF-interference and spectrum signature data for areas of industrial, military and scientific research and development.* . . . The MITRE Corp., Bedford, Mass., has established a new Communications Div. to consolidate the firm's communications activities for the Air Force and other sponsors. The new group is to work primarily with the Air Force Electronic Systems Div. and will be involved in such communications programs as the Automatic Voice Network (AUTOVON). The division will also provide technical support to the National Range Div. of the Air Force Systems Command. . . . *Giannini Controls Corp., Duarte, Calif., has established a new Process Control Sales Dept. to expand its activities in the marketing of on-line instrumentation.*

Missile/Space Stock Index

Prevention of a steel strike had a stimulating effect on the Missile/Space Stock Index as it did the general stock market. The index has stayed at record highs of better than 125 for some time. Other factors contributing to the continued interest in defense and space stocks have been publicity about the *Manned Orbiting Laboratory* program and the continuing fighting in Viet-Nam.



100 = CLOSING PRICES OF 19 REPRESENTATIVE AEROSPACE FIRMS DEC. 31, 1964
STOCK PRICES FURNISHED BY MERRILL LYNCH, PIERCE, FENNER AND SMITH

AWARDS

AIR FORCE

$22,952,523—**Hughes Aircraft Co.**, Tucson, Ariz., to modify *Falcon* missiles.

$9,041,144—**The Boeing Co.**, Seattle, for continued work on the *Minuteman* missile program.

$6,000,000—**International Telephone and Telegraph Corp.**, Federal Electric Corp., Paramus, N.J., to provide a submarine cable communications system to be used in support of missile programs on the Eastern Test Range.

$5,945,707—**Westinghouse Electric Corp.**, Baltimore, to make communications sets.

$4,000,000—**McDonnell Aircraft Corp.**, St. Louis Mo., to study a part of the *Manned Orbiting Laboratory* program.

$2,290,076—**International Business Machines Corp.**, Rockville, Md., to do research on programming techniques.

$2,160,000—**Radio Corp. of America**, Missile & Surface Radar Div., Moorestown, N.J., for operations and services for the Moorestown spacetrack facility.

$1,433,900—**General Motors Corp.**, Oak Creek, Wisc., for work on the *Titan II* missile guidance system.

$1,241,000—**American Bosch Arma Corp.**, Garden City, N.Y., to work on a re-entry system program.

$1,000,000—**Avco Corp.**, Wilmington, Mass., to work on a space re-entry system.

$1,000,000—**North American Aviation, Inc.**, Los Angeles, initial installment on a $3.3-million contract for *X-15* program.

$504,680—**Radio Corp. of America**, Aerospace Systems Div., Burlington, Mass., for APN-155 altimeters.

$499,198—**General Precision, Inc.**, Systems Div., Binghampton, N.Y., for maintenance of flight simulator.

$480,000—**Whittaker Corp.**, Telecomputing Services, Inc., Panorama City, Calif., for extension of services to provide data reduction and computing services at Edwards AFB, Calif.

$283,278—**Dynamics Research Corp.**, Stoneham, Mass., for depot level maintenance for *Titan II*.

$183,718—**Ball Bros. Research Corp.**, Boulder, Colo., to fabricate assemble, test and integrate biaxial solar pointing control and telemetry systems for research rockets.

$180,000—**General Dynamics**, Ft. Worth, Tex., for maintenance, operation and improvements of the Air Force radar target scatter site.

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$169,500—**Sperry Rand Corp.**, Sperry Gyroscope Co., Great Neck, N.Y., for study of ECM aerospace antenna system.

$161,000—**Brown Engineering Co.**, Huntsville, Ala., to perform a research study in electronics.

$132,904—**Rocket Research Corp.**, Seattle, for investigation of a high energy monopropellant.

$130,233—**Hughes Aircraft Co.**, Fullerton, Calif., for engineering services for the fabrication of an experimental model of a ranging and homing device plus installation and testing, plus a technical report.

$100,000—**Geoscience Ltd.**, Solana Beach, Calif., for biophysics research.

$97,000—**Lockheed Aircraft Corp.**, Lockheed Missiles & Space Co., Sunnyvale, Calif., for development of space flight devices to diminish or prevent the deconditioning effects of weightlessness and other environmental factors.

$82,503—**Goerz Optical Co., Inc.**, Systems Div., Pittsburgh, for high-precision automatic accelerometer test stand.

$75,564—**Stanford University**, Stanford, Calif., for research on molecular biology applications of mass spectrometry.

$64,650—**General Motors Corp.**, AC Electronics Div., Milwaukee, for technical orders in support of the *Titan II* inertial guidance system.

$58,804—**Space General Corp.**, El Monte, Calif., for *Nike-Iroquois* rocket hardware.

$50,042—**Massachusetts Institute of Technology**, Cambridge, Mass., for an experimental investigation of electrical breakdown of plasma coated antennas in wind tunnels.

$50,000—**General Motors Corp.**, AC Electronics Div., Milwaukee, for installation and checkout of depot maintenance ground equipment in support of *Titan II*.

$28,646—**Stanford University**, Stanford, Calif., for continuation of research on analytical studies of nonequilibrium flow.

ARMY

$12,693,929—**Dynamics Corp. of America**, Bridgeport, Conn., in two contracts for generator sets.

$5,837,378—**Hughes Aircraft Co.**, Culver City, Calif., for continuation of *TOW* missile research and development.

$4,909,514—**Radio Corp. of America.**, Communications Systems Div., Camden, N.J., for AN/PRC-25 radio equipment.

$4,542,538—**Dynalectron Corp.**, Washington, D.C., to operate and maintain government-owned data collection facilities at White Sands Missile Range, N.M.

$2,020,002—**Sperry Rand Corp.**, Phoenix, Ariz., for electronics equipment.

$1,884,822—**Avco Corp.**, Ordnance Div., Richmond, Ind., for adapter boosters and ammunition.

$1,400,000—**Highway Products, Inc.**, Kent, Ohio, for manufacture of *Hawk* launchers.

$1,250,000—**Raytheon Co.**, Lexington, Mass., for equipment for the *Hawk* missile system.

$1,140,000—**Babcock Electronics Corp.**, Babcock Aerospace Div., Costa Mesa, Calif., in various contracts for remote control systems and radio receiver-decoder units used on aircraft-type missile target vehicles.

$1,082,254—**General Electric Co.**, Schenectady, N.Y., to build 13 trailer-mounted power plants for use with mobile *Nike-Hercules* missiles.

$962,961—**General Electric Co.**, Missile and Space Div., Valley Forge Space Technology Center, Philadelphia, for research and development for discrimination criteria identification and evaluation for the *Nike-X* project office.

$772,000—**Fullerton Construction Co.**, Sacramento, Calif., for autodin facility addition, McClellan AFB, Calif.

$661,385—**Chromcraft Corp.**, St. Louis, for two contracts for 2.75-in. rocket launchers.

$560,000—**Hughes Aircraft Co.**, Ground Systems Group, Fullerton, Calif. for encoding-decoding devices.

$99,000—**Kaman Aircraft Corp.**, Bloomfield, Conn., to install drone flight controls in two CH-21C helicopters, which will be used as targets for *Redeye* missiles.

$82,892—**Space Data Corp.**, Phoenix, Ariz., for ballistic study of a family of rockets.

$56,561—**Microwave Electronics Corp.**, Palo Alto, Calif., for research and development in the microwave acoustics area.

$47,696—**Mechtron Corp.**, Orlando, Fla., for *Pershing* modification kits.

$44,265—**Spaco**, Huntsville, Ala., for engineering support and component fabrication for a helicopter-borne aerial artillery rocket weapon system.

$26,167—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for *Lance* missile secondary injection thrust vector control study.

Emerson Electric Co., Spectral Technology and Applied Research Div. Santa Barbara, Calif., to study a new method of guiding missiles (amount not disclosed).

NAVY

$20,923,369—**Westinghouse Electric Corp.**, Pittsburgh, for research of nuclear-propulsion plants for ships.

$10,476,000—**General Electric Co.**, New York City, for research on nuclear propulsion plants for ships.

$8,000,000—**General Telephone and Electronics Corp.**, Sylvania Electric Products Inc., Mountain View, Calif., to produce electronic equipment.

$2,550,000—**Ryan Aeronautical Co.**, San Diego, to make target drones.

$2,269,843—**Aerojet-General Corp.**, Downey, Calif., for design work on classified project.

$2,000,000—**Litton Systems, Inc.**, Woodland Hills, Calif., to produce specia support equipment for inertial navigation systems for aircraft.

$1,950,000—**Lockheed Aircraft Corp.**, Watchung, N.J., for fire contro system.

$1,898,748—**Fischback & Moore, Inc.**, Dallas, for communications systems.

$1,300,000—**General Precision Equipment Corp.**, General Precision, Inc

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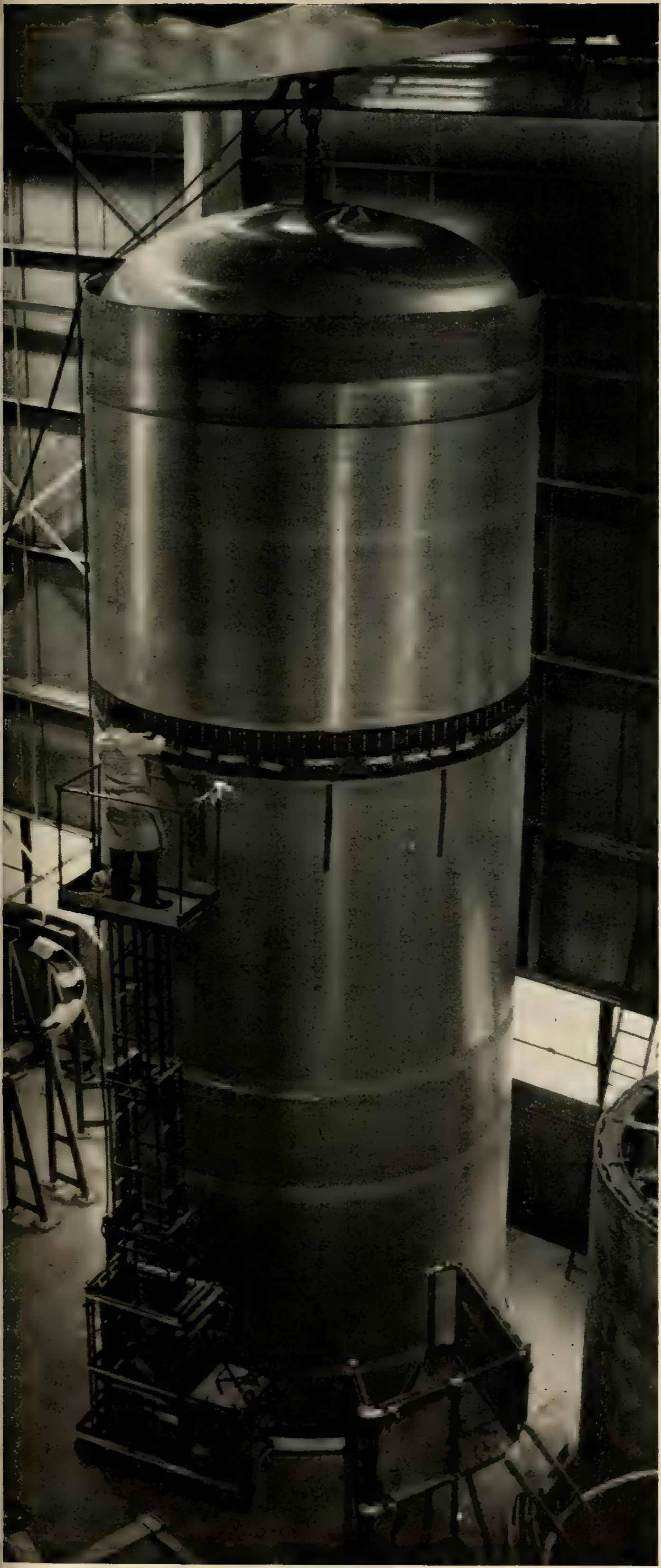

BFG builds largest filament-wound rocket motor case

Before this giant rocket motor case is complete, the two sections shown in the photo will be joined to a third section. The final structure will be 50 feet high, 13 feet in diameter . . . the largest filament-wound motor case yet built.

The sections are made from glass filament and resin wound on a mandrel. The resultant structures offer very high strength with much less weight than metal; have distinct advantages for advanced rocket requirements.

These giant motor cases are being built for special evaluation, on subcontract to Thiokol Chemical Corporation for the U. S. Air Force.

B.F.Goodrich offers a complete capability in filament winding — long-term research and development programs in resin chemistry and systems, years of experience in filament construction, advanced production facilities for building complete structures, including insulators, at one location.

For complete information contact *B.F.Goodrich Aerospace & Defense Products, a division of The B.F.Goodrich Company, Dept. MR-9, Akron, Ohio 44318. Phone: Area Code 216 253-1171. In Europe: IBFG Aerospace Products-Europe, Albertus de Oudelaan 2, Voorburg, The Netherlands.*

B.F.Goodrich

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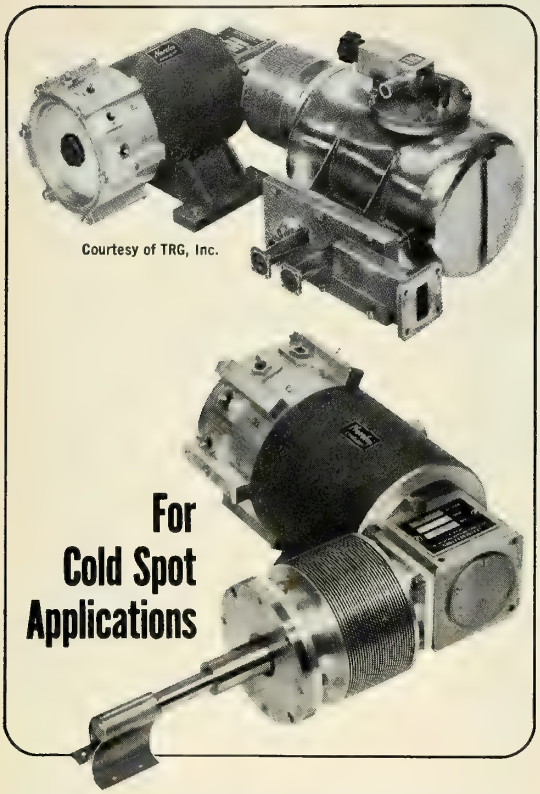
cryogem®



A Global Communications Receiver has been developed for the U.S. Army Satellite Communication Agency (SatCom), Fort Monmouth, New Jersey. This compact, ultra-sensitive, remotely tunable receiver has been designed and supplied by TRG, Incorporated, a subsidiary of Control Data Corporation. Use will be in the transportable ground terminals of the SatCom system.

The antenna-mounted portion of this system contains an integrated parametric amplifier/cryogenic refrigerator combination. The cryogenic refrigerator is the new, self-contained Norelco CRYOGEM—a light weight miniaturized refrigerator.

This Stirling-cycle unit is ideally suited for industrial and military applications with guaranteed performance in all attitudes. Continuous cooling can be provided for IR detectors, parametric amplifiers, lasers and other solid state devices. The CRYOGEM is an air-cooled refrigerator—that can be adapted to any application or design requirement. Write today for additional information.

Norelco CRYOGENICS

NORTH AMERICAN PHILIPS COMPANY, INC.
Mendon & Angell Roads, Ashton, Rhode Island 02805

A-65

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Glendale, Calif., to modify the fire-control system for Mark 48 torpedoes.

$1,145,003—**General Electric Co.**, Pittsfield, Mass., to make *Polaris* guidance-test sets.

$692,000—**Radio Corp. of America**, Missile & Surface Radar Div., Moorestown, N.J., for electronic equipment.

$98,685—**North American Aviation, Inc.**, El Segundo, Calif., for the study and development of a prototype deep water metal cutting torch.

NASA

$9,255,375—**Ling-Temco-Vought, Inc.**, LTV Aerospace Corp., Astronautics Div., Dallas, to provide overall system management for the four-stage, solid-fueled *Scout* launch vehicle.

$8,600,000—**Douglas Aircraft Co.**, Missile and Space Systems Div., Huntington Beach., Calif., for additional work on the *Saturn* moon rocket.

$901,058—**A-V Corp.**, Houston, for photographic and audio-visual services.

$875,000—**Electronic Associates, Inc.**, West Long Branch, N.J., for purchase of a hybrid computing system for primary application to design studies in the *Saturn* booster program.

$800,000—**The Marquardt Corp.**, Van Nuys, Calif., for the development of a waste management system for application to the *Apollo* Extension System.

$314,000—**North American Aviation, Inc.**, Space and Information Systems Div., Downey, Calif., for *Apollo* water impact study.

$298,535—**Dallas County Hospital**, Dallas, for *Apollo* experiment S-15 on influence of zero-gravity on single living human cells.

$285,254—**Radio Corp. of America**, Astro-Electronics Div., Princeton, N.J., for the AVCS subsystem.

$279,750—**American Science and Engineering, Inc.**, Cambridge, Mass., for a program of X-ray astronomy from sounding rockets.

$250,000—**Textron Electronics, Inc.**, MB Electronics Div., New Haven, Conn., for vibration test equipment.

$245,000—**Radio Corp. of America**, Astro-Electronics Div., Princeton, N.J., for the *TOS* program.

$240,000—**Doan Electric Co.**, Cleveland, Ohio, for construction of electrical instrumentation and control system for the zero-gravity facility.

$205,500—**Thiokol Chemical Corp.**, Huntsville, Ala., for fabrication of rocket motors and conduct of a reliability and quality assurance program.

$195,275—**Hughes Aircraft Co.**, Culver City, Calif., for flexible automatic circuit tester.

$162,000—**Atkins & Merrill, Inc.**, Engineering Models Div., Sudbury, Mass., to design and construct an aero-elastic replica model of the *Apollo* Service Module.

$141,449—**Astrodata Inc.**, Comcor, Inc., Anaheim, Calif., for a portable analog computer system.

$131,697—**General Dynamics Corp.**, Convair Div., San Diego, for a preliminary design of components for a floxed *Atlas* vehicle and a flox diffusion test program study.

$126,000—**Lockheed Aircraft Corp.**, Missiles and Space Div., Palo Alto, Calif., for vibration-vacuum screening of space lubricants.

$125,000—**Aerojet-General Corp.**, Sacramento, Calif., to inspect Algol motors and nozzle and related services; fabricate ground adjustable nozzles and related hardware.

$123,950—**Avco Corp.**, Research and Advanced Development Div., Wilmington, Mass., to develop and evaluate a Mars lander sterilization container.

$81,629—**Beckman Instruments**, Fullerton, Calif., for gas analysis system.

$71,000—**M. F. Snyder and Co.**, Birmingham, Ala., for construction of addition to LOX impact test cells building.

$64,000—**Marquardt Corp.**, Van Nuys, Calif., for *Apollo* S/M reaction control engines and valves.

$62,084—**Bell Aerospace Corp.**, Aerosystems Co., Niagara Falls, N.Y., for study on thermal protection systems based on porous ceramic designs for application to manned lifting entry vehicles.

$60,000—**Honeywell Inc.**, Aeronautical Div., St. Petersburg, Fla., for guidance system electronic unit study and preliminary test program.

$59,983—**TRW Inc.**, Systems Group, Redondo Beach, Calif., for particle acceleration by evaporation pressure.

$59,500—**Thiokol Chemical Corp.**, Elkton, Md., for assembling igniters and loading rocket motors.

$58,940—**IIT Research Institute**, Chicago, for development of a corrosion inhabited heat transfer fluid for ECS systems.

$47,074—**Vega Precision Laboratories**, Vienna, Va., for X-band telemetry transmitters.

$32,362—**United Aircraft Corp.**, Hamilton Standard Div., Windsor Locks, Conn., for study to relate *Apollo* space unit technology to the field of hyperbaric medical therapy.

$31,500—**General Electric Co.**, Semiconductor Products Dept., Syracuse, N.Y., for high reliability semiconductors.

$29,000—**Honeywell Inc.**, Radiation Center, Boston, for three-axis magnetometer fluxgate sensor sets.

$27,950—**Bristol Co.**, Cleveland, for potentiometers.

$27,000—**Gulton Industries**, Instrumentation Products Div., Hawthorne, Calif., for instrumented acoustic measuring system.

$25,578—**Electro Mechanics Co.**, Austin, Tex., for antennas.

GCA Corp., GCA Technology Div., Bedford, Mass., for experimental and theoretical studies in planetary aeronomy (amount not disclosed).

Burns and Roe, Inc., New York City, for a study of a storage and distribution system for high-pressure gases (amount not disclosed).

INDUSTRY

$2,300,000—**Potter Instrument Co., Inc.**, Plainview, N.Y., from **General Telephone and Electronics Corp.**, Sylvania Electric Products, Inc., New York City, for production of digital magnetic tape transports.

$2,000,000—**General Time Corp.**, Acronetics Div., Rolling Meadows, Ill., from **North American Aviation, Inc.**, Space and Information Systems Div., Downey, Calif., to produce the unique timekeeping device for the *Apollo* lunar spacecraft.

$1,852,000—**General Telephone & Electronics Corp.**, Lenkurt Electric Co., Inc., San Carlos, Calif., from **Astrodata, Inc.**, Anaheim, Calif., to

INSPIRATIONAL THOUGHTS FOR THE TECHNICALLY INCLINED

ITTSY BITS

Why the baby talk? We're bubbling with happiness over our latest baby. It's the fifth generation of a native-born family, and although the smallest, it is undoubtedly the best today by virtue of its breeding. This latest offspring is the new Size 11 Shaft Encoder we have named ADAC. Now ADAC, like its ancestors, is characterized by engraved drums which are interconnected by high-speed, anti-backlash, continuous gearing and by special brushes which interrogate and read out the drum position on the run or at rest.

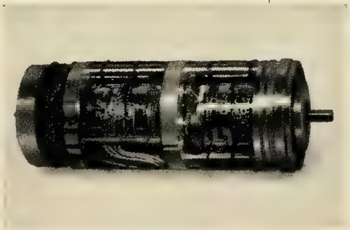
At this point we can almost hear you say, "So what's new about that?" It's an all-around better baby! First of all, the ADAC is a high-speed device designed to run at 200 rpm input shaft speed. It can be interrogated on a bit-by-bit basis in 1 millisecond while on the run. Even more important, it packs a lot of bits into a tiny package — for example, in a can only 1.062" in diameter and 2.355" long, you can buy a count of 16,384 bits (2^{14}). We have also included all the advantages of V scan (U scan optional) for unambiguous binary outputs and have incorporated all necessary diode logic as well.

ADAC units are available as binary encoders covering the range of 2^8 through 2^{14}. We also have BCD encoders in decimal counts to 99999 and angular counts to 359.9°. A 2^{10} gray code device is also available.

To give you a better idea of the new encoder's breeding, we think these statistics will prove helpful.

TYPE SIZE 11 UNITS

CHARACTERISTIC	BINARY	BCD
Voltage/Current	28vdc/20ma	28vdc/20ma
Interrogation	Pulsed or continuous	Serial
Readout	On run and static	
Output	Parallel	Parallel digit, serial between digits
Time Sharing	Isolation diodes are standard to permit time sharing	
Counts per revolution	126 or 256	100
Starting Torque	0.20 in. oz.	0.20 in. oz.
Accuracy	± 1 bit for any given input shaft angle	
Life	5,000,000 revolutions at 300 rpm (min)	



SUMMARY OF OTHER FEATURES

■ Solid gold alloy drums and brushes ■ In-line brush geometry ■ Continuous precision gearing ■ Flush conducting and non-conducting drum surface ■ Steel shafts and precision bearings ■ Standard Size 11 mounting ■ Isolation diodes for positive and negative logic included.

The proud parents are anxious to send you a brand new brochure celebrating the event, so let us know who you are and where we can find you.

INERTIA

Sometimes it takes a sharp push to get things going. We say we're working against inertia. At other times we pull and haul to get things "off the dime" overcoming a kind of viscous unwillingness. But inertia and viscosity can be real advantages instead of irritants. There are times, for example, when a tach generator (we make them, too) can be replaced by a viscous or inertial damped servo motor. There's been a lot written on the subject, and we're not going to discuss the obvious advantages of these devices except for the following summary and an invitation to write for more details.

TYPICAL DAMPED SERVOMOTOR CHARACTERISTICS

TYPE—VISCOUS

SIZE	8	8
Part Number	CMO 0180 450	CMO 1302 450
Stall Torque	0.26 in. oz.	0.31
No-Load Speed	5190 rpm	6200
Rotor Moment of Inertia	0.69 gm cm^2	0.48
Theoretical Accel at Stall	28,600 rad/sec^2	48,500
Time Constant	0.0531 sec	0.0119
Fly Wheel Damping	—	196 dyne-cm-sec
Fly Wheel Inertia	—	4.6 gm cm^2
Weight	2.0 oz.	2.6

TYPE—INERTIAL

SIZE	11	15	18
Part Number	CRO 1300 660	T1310-418	R1320-2B
Stall Torque	0.60	1.45	2.25
No-Load Speed	6000	4500	4500
Rotor Moment of Inertia	1.45	5.48	6.25
Theoretical Accel at Stall	30,700	18,700	26,000
Time Constant	0.022	0.0255	0.0185
Fly Wheel Damping	100	750	750
Fly Wheel Inertia	10	100	100
Weight	6.0	12.0	18

KEARFOTT DIVISION
GENERAL PRECISION INC.
AEROSPACE GROUP
Little Falls, New Jersey

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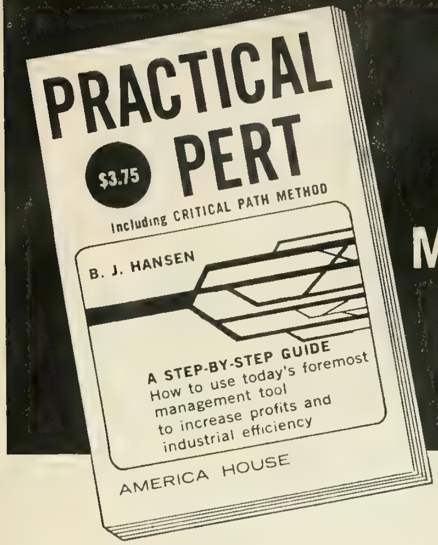
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(member of the original Polaris-PERT Team)

You get the complete **PERT** system and, for the first time, a **PERT** technique showing you how to predict and monitor profit on a continuing bi-weekly cycle.

Chapter XI, "Profit **PERT** and Incentives," brings you the Martin Company case history showing how the Titan III **PERT**-profit system works: In the words of Secretary of Defense Robert McNamara, "(Titan III) is probably the best managed contract we have, and it is the best managed almost entirely because of the tremendous incentive given to that contractor in the form of potential profit increases to hold his costs down."

PRACTICAL PERT tells how and when to meet contract obligations, how to keep programs on schedule, how to win highest incentive fees. **PERT,** developed for the nation's defense programs, can be applied to management operations to monitor profit as well as cost, time and performance in the fields of construction, chemical processing, manufacturing . . . and wherever complex systems are involved.

PRACTICAL PERT contents

I INTRODUCTION TO PERT
II THE ABC'S OF PERT
III PERT & TIME
IV HOW PERT PLANS
V HOW PERT CONTROLS
VI BUILDING PERT
VII WHAT IS NETWORKING
VIII REFINING THE NETWORK
IX MEASURING MANAGEMENT RISK
X PERT & COST
XI PERT COSTS & COMPUTERS
XII PROFIT PERT & INCENTIVES
XIII PERT DATA DISPLAY

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engineer, furnish and install an instrumentatio data transmission system for White Sands Missile Range, N.M.

$1,500,000—**Fairchild Space and Defense Systems** Syosset, N.Y., from **Grumman Aircraft Engineering Corp.,** Bethpage, N.Y., to design an produce a solid-state programmer for critica control functions in the unmanned mission planned early in the *Apollo* program.

$1,000,000—**Erie Forge & Steel Co.,** Erie, Pa. from **Orrison, Knudsen, Perini, and Hardeman Inc.,** Titusville, Fla., for parts for a *Saturn* launching complex, Merritt Island, Fla.

$750,000—**Goodyear Tire & Rubber Co.,** Aviatio Products Div, Akron, Ohio, from **Hercules Powder Co.,** Wilmington, Del., for the insulation of third stage motor cases for th advanced *Minuteman II* missile.

$500,000—**International Telephone and Telegrap Corp.,** Industrial Products Div., San Fernando Calif., from **Northrop Corp.,** Norair Div. Hawthorne, Calif., for tandem power supplie for launching the infrared-guided air-to-ai *Sidewinder* missile from the wingtips of th F-5A and F-5B aircraft.

$269,000—**Ets-Hokin & Galvan Electric Co.,** Denver, from **The Boeing Co.,** Seattle, to perform modification of the *Minuteman* antenna system at Minot AFB, N.D., and Ellsworth AFB, S.D

$300,000—**Babcock Relays,** Costa Mesa, Calif. from **North American Aviation, Inc.,** Autonetics Div., Anaheim, Calf., for precision hig reliability relays for the mission sequencer i the *Apollo* spacecraft.

$275,000—**Allied Engineering Co.,** South Gate Calif., from **The Boeing Co.,** Seattle, to modify the antenna system of the 150-missile *Minuteman* ICBM wing near Malmstrom AFB, Mont

$137,154—**Radio Corp. of America,** Communications Systems Div., Camden, N.J., from **Airborne Instruments Laboratory,** Deer Park N.Y., for an experimental model recorder reproducer.

$115,000—**Radio Corp. of America,** Aerospac Systems Div., Burlington, Mass., from **McDonnell Aircraft Corp.,** St. Louis, for AN/APN 155 low level altimeter.

REQUESTS FOR BIDS

National Aeronautics and Space Administratio
Washington, D.C.

Negotiations are being conducted with Barringer Research, Inc., to conduct research to determine the feasibility of spectrometric measurement of trace components of planetary atmospheres. For information only; RFP not available

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Purchasing Office
George C. Marshall Space Flight Center
NASA
Huntsville, Alabama 35812

Negotiations will be conducted with Genera Dynamics/Convair for continuation of continuum carbon emission for afterburning studies. For information only; RFP not available.

Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135

Negotiations will be conducted with TRW Systems Group for a follow-on procurement fo an investigation of ion beam diagnostics an neutralization. For information only; RFP n available.

Chief
Bureau of Ships
Navy Department
Washington, D.C. 20360

Research and development sources sought fo conducting a preliminary system design for a anti-submarine warfare ship integrated comba system for the 1970-1980 decade.

Office of Naval Research
Washington, D.C. 20360

Negotiations will be conducted with Vitr Laboratories for further research on the Nava Research Laboratory's research and developme program for the fleet ballistic missile. For information only; RFP not available.

Manned Spacecraft Center
Gemini Flight Support Procurement Section
Houston, Texas 77058

Preliminary definition study of the Allis-Chalmers fuel cell system will be negotiated with Nort American Aviation, Inc. For information onl RFP not available.

General Electric's Missile & Space Division selected as a prime contractor for the

MANNED ORBITING LABORATORY

Openings now on MOL and other challenging programs such as Nimbus, OAO, and Gravity Gradient Stabilization System:

SYSTEMS ANALYSIS ENGINEERS

Interpret satellite systems design and operational mission requirements. Identify and analyze performance parameters and assess their influence on the vehicle system. Perform design trade-off analyses and prescribe acceptable systems behavior, operating domains, tolerances and performance variations. Develop the analytical facility to implement systems synthesis and optimization and evaluate development progress, malfunction, reliability, effectiveness, vulnerability and capability of the vehicle systems. Requires BS/MS EE, ME or Physics and broad understanding of missile/spacecraft subsystems.

INFRARED AND OPTICS SPECIALIST

Responsible for originating, integrating and presenting technical studies of a systems analysis nature. Plan and direct experimental programs to validate new systems and subsystems concepts. Interpret the tactical and strategic technical requirements of the customer in the IR/Optical area. Requires MS/PhD in Physics and broad systems experience in IR and/or optics instrumentation.

ELECTRICAL SUBSYSTEMS ENGINEERS

Responsible for the design, development testing and qualification of the assigned Spacecraft Electrical Subsystem, including all components. Emphasis is on airborne control for the electrical distribution in a space vehicle, including electrical power and signal distribution for AGE. Requires BSEE with minimum of 4 years' applicable experience.

RELIABILITY ENGINEERS

Individuals will be responsible for determining reliability requirements on assigned programs, to include: design, reliability; failure mode and effects; system and component analysis; test design and evaluation; failure analysis; maintainability; risk assessment; cost analysis and vendor reliability. Requires BSEE or Physics and 3 to 5 years' applicable experience.

ENGINEERS — SYSTEMS EFFECTIVENESS

Establish systems effectiveness criteria for manual space systems. Study and assess systems and mission data; interpret customer effectiveness directives; devise and specify figures of merit and accountable factors; estimate parameters; and set preliminary contractual effects. Experience required in operations analysis, system analysis, mission analysis, probability theory and reliability.

SYSTEMS ENGINEERS — ELECTRICAL

To lead and perform studies of electrical systems for spacecraft auxiliary power and propulsion. Included here is the definition of systems requirements, determination of system characteristics, performance optimizations, and evaluation of the state-of-the-art in the areas of power conditioning equipment (static switching circuits, transformer design, etc.), alternators, E-M pump technology, control systems, electrical power transmission, and electronic payload equipment. A broad range of experience in electrical power systems and analog simulation is desired, with proven analytical ability, and skill in communicating (written and oral presentations).

GUIDANCE AND CONTROL SYSTEMS ENGINEERS

Conceive and conduct analytical studies resulting in the design and development of sophisticated systems for the navigation, guidance and control of Space Vehicles. Both active and passive techniques are currently under study and development for the control of Orbiting Spacecraft, rendezvous techniques, interplanetary flight and specialized military systems. Requires BSEE, ME or Physics. Intermediate and senior positions.

ENGINEERS — THERMODYNAMICS

Responsible for the design adequacy of orbital and re-entry space vehicles with respect to thermodynamics, heat transfer and aerodynamic heating factors. Will engage in synthesis and parametric studies pertaining to configuration heat protection system performances and internal cooling system performance. Requires MSME, AE or Chemical Engineering with 2 to 6 years' aerospace experience.

OPERATIONS ANALYSIS ENGINEERS

3 to 10 years' experience in space vehicle systems design, development, test and operations. Emphasis on hardware knowledge, systems integration and data analysis. Must be interested in responsible assignment and customer contact. Assignment is in technical support of military space programs.

PROJECT ENGINEERS

Responsible for technical direction of all work on assigned programs. This includes interpreting customer requirements, technical integration, establishing program direction and funding, and measurement of progress. Requires engineering degree, strong administrative capability and a thorough knowledge of engineering, manufacturing and quality control.

ENGINEERS — COMMAND & TELEMETRY DESIGN

Responsible for the design of new spacecraft components from conceptual phase through detailed design, production, test and use. Includes airborne and ground telemetry, voice and video circuitry and sensor components. Requires comprehension of analog and digital circuitry, receiver and transmitter design experience and a knowledge of microelectronics. BS/MSEE or Physics with minimum of 4 years' experience.

ENGINEERS — GROUND SUPPORT EQUIPMENT

Design and development of checkout, handling, transport, acquisition display, and control equipment for orbiting spacecraft. Assignments include: thermal control equipment; propulsion system checkout; life support equipment; assembly alignment and transport equipment; sensing, control, acquisition and conditioning equipment; and special test support equipment. Requires technical degree plus 6-10 years' aerospace experience.

ENGINEERS — SIMULATION

Responsible for analysis specifications, monitoring and evaluation of crew equipment and simulation systems design from the conceptual to operable stage. Will develop simulation test plans, implement their operation and evaluate resultant data. Provide thermal control systems engineering, training systems engineering, and crew operations integration. Knowledge of software simulation systems and programming and operation of analog/digital computers. Engineering degree plus 4-6 years' applicable experience required.

HUMAN FACTORS PSYCHOLOGISTS

Human factors analysis of AGE, AVE, and crew accommodation equipment for manned space vehicles. Evaluation of adequacy of design as regards reliability, safety, service and maintenance. Determine optimal work-place layout, displays and controls requirements, lighting conditions and support-restraint devices. Establish training and simulation requirements and define spacecraft checkout interface. Relate anthropometric, pressure suit and restraint data to determination of crew visual-manual function envelope. Requires BS/MS Psychology or Engineering and 4-8 years' aircraft and/or space vehicle experience.

ENGINEERS — LIFE SUPPORT SYSTEMS

Analysis, design, development, test and evaluation of life support equipment which will enable men to perform in space for extended periods of time. Subsystems include cabin pressure control, thermal control, pressure suit, support equipment, waste collection and personal hygiene, safety and survival. Requires technical degree and direct comparable experience.

SURVIVABILITY SYSTEMS ENGINEERS

Plan, direct and contribute to survivability studies of advanced space systems subject to natural and man-made radiation environment. Efforts include: design and circuit analyses of transient radiation effects on electronic systems; design and conduction of radiation tests on components and subsystems; analysis of the generation mechanism, transmission and interaction of various forms of energy from a nuclear weapon. Requires BS/MS EE, ME, or Physics with several years of experience in either circuit design, electronic hardening techniques and a familiarity with nuclear weapons technology.

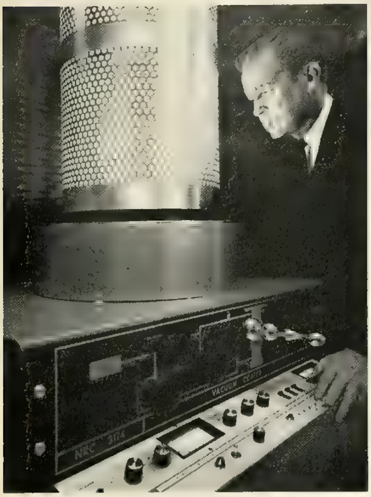
You are invited to inquire further by writing to: Mr. J. S. Barson, Room 394J-2,
Valley Forge Space Technology Center, General Electric Co., P.O. Box 8555, Philadelphia, Pennsylvania.

MISSILE & SPACE DIVISION

GENERAL ELECTRIC

An Equal Opportunity Employer

New Product of the Week: Microelectronics Coater



A vacuum coater for microelectronics and optics deposition work has been developed by National Research Corp., a subsidiary of the Norton Co.

The Model 3114 coater provides high vacuum blank-off in the 10^{-8} torr range. The unit features a liquid nitrogen baffle, a log and linear-scaled ionization gauge control and a 4-in. diffusion pump system. The system, which measures 31 x 33.5 in., also includes a 5-cfm mechanical pump, an ionization gauge tube, two thermocouple gauge tubes and a raised baseplate with bell jar, guard and gasket.

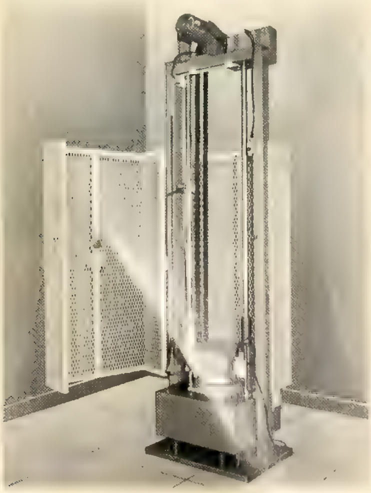
The evaporation filament power supply consists of a 2-kva multi-voltage tap power transformer (100% duty rated) and a panel-mounted variable transformer and ammeter.

Circle No. 151 on Subscriber Service Card

Shock Machine

L.A.B. Corp. is marketing the SDB-16-66-150 shock machine, which produces vertical shocks using gravity and compressed air as the velocity-producing force on the carriage.

A pneumatic cylinder mounted on one side of the structure is connected to the carriage through a cable and pulley system to provide part of the force needed for higher energy shock pulses than are available from gravity alone. Impact velocities equivalent to a free fall of 10 ft. are achieved within a distance of 5 ft. When testing lower-energy shocks, the booster cable is disconnected and the shock tested is used as a conventional gravity-operated machine.



The device has a 16-in.-sq. carriage and a test load capacity of 150 lbs. The machine's seismic base is spring-suspended and damped to 85% of critical.

Circle No. 152 on Subscriber Service Card

Waveguide Tripler

An X-band to Ka-band harmonic waveguide tripler, designed to replace Ka klystrons in test equipment, has been developed by Sylvania Electric Products, Inc.

The Model SYG-2001 is available throughout the range of the firm's RG-52/U input waveguide. It employs a gallium arsenide frequency varactor diode and offers 25% minimum efficiency. Minimum power output is 50 milliwatts with an output bandwidth of 100 mc. In recent tests, the device was run continuously without adjustment or interruption for 13 months, the firm said. It is available with or without an X-band kylstron.

Circle No. 153 on Subscriber Service Card

Linear Flashtube

Xenon, Inc., has developed a prefired linear flashtube, designed for high-energy laser pumping.

The Model C6.5-103 has a 10,000 joules/pulse input capability in 6.5 in. of arc length. Spectral characteristics approximate those of natural sunlight. The unit features 7/16-in.-dia. solid O.F.H.C. copper electrode feedthroughs that extend to the tube exterior.

Circle No. 154 on Subscriber Service Card

Solenoid Cartridges

A line of high-pressure solenoi cartridges featuring lower space requirements and a reduction of potential leakage points is being marketed by Flui Power Accessories, Inc.

The units are available in combinations of 2-way, 3-way and 4-way style and in all standard voltages. Pressure up to 3,000 psi are standard; highe pressures are available on special order According to the firm, replacement ca be accomplished in minutes without disconnecting fluid-carrying lines.

Circle No. 155 on Subscriber Service Card

Modeling Material

A method of site reproduction usin low-density polyurethane to produc topographical models with machin accuracy has been introduced by Topofoam.

The models are machined fro single blocks of polyurethane. An range of elevations can be reproduce to any scale required, the firm says. Th lightweight models can be coated wit metal chrome plating, epoxy finish o paint finish.

Circle No. 156 on Subscriber Service Card

Differential Switch

Custom Component Switches, Inc is marketing the Model 674D differen tial switch. The unit can sense a Δ change as low as 1 psi or as high as 10 psi at system pressures of 5,000 psi. is available as a weather-proof or as a U.L.-listed explosion-proof switch.

Circle No. 157 on Subscriber Service Card

Isotropic Graphite

A dense, isotropic graphite raw ma terial for metallurgical and electron applications is available from Areme Products, Inc.

The RG-504 graphite offers hig structural uniformity for higher oxid tion resistance, the firm said. Machinin to close tolerances and fine detail is po sible because of the close grain. Puri ranges are as low at 200 ppm with fle ural strength of 10,000 psi. The materi is available in standard rods and plat ranging from 0.25 to 4 in. in diamete

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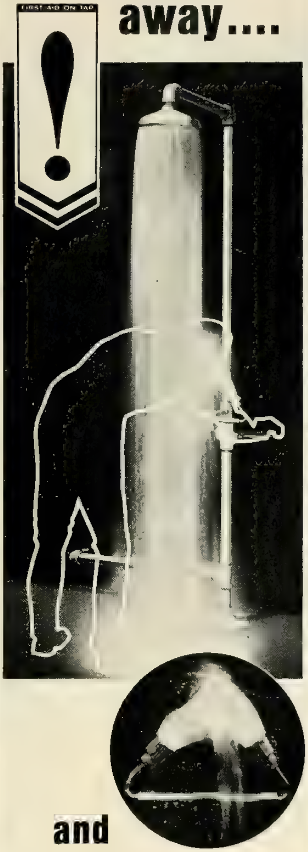

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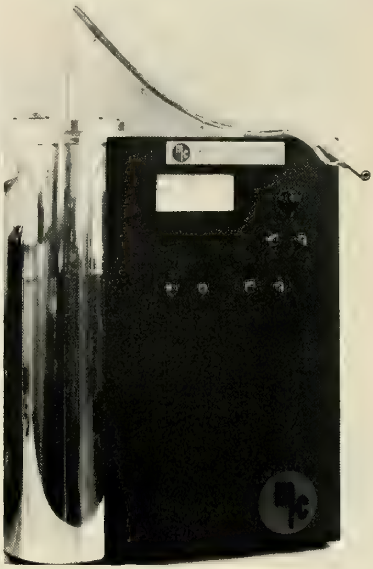
Cryogenic Cooler

A device for cooling single crystals and other small specimens to temperatures down to —180°C without frosting has been developed by Materials Research Corp.

Called the Cryo-Collimator, the device has application in X-ray diffraction and absorption investigations, low-temperature resistivity studies, light microscopy of organic and inorganic materials, Hall Effect measurements and absorption spectrometry. A stainless steel collimation head is mounted on the end of a flexible metal transfer tube so that the device can be used alone, with laboratory apparatus or adapted for use in other equipment.



In operation, cold nitrogen gas is generated in the dewar of the unit. The gas passes through a flexible, vacuum-insulated transfer tube and special collimation nozzle on to the sample, which is generally placed within 2 in. of the collimation nozzle. Gas flow is regulated by a control valve.

Cool gas flow capability is rated at approximately 40 cu. ft. per hour. The 15-liter capacity of the dewar allows 6 hours of operation at the —180°C level. Stability is within ±0.5°C.

Circle No. 159 on Subscriber Service Card

Hybrid Computing System

An analog/hybrid computing system for industrial, university and other research facilities has been introduced by Electronic Associates, Inc.

The computer, designated EAI 680, is the fourth in EAI's family of general-purpose hybrid system. It combines analog and digital computing elements into a single, integrated system to solve problems too complex or uneconomical for solution using either analog or digital techniques alone, the firm said.

The model includes up to 156 analog amplifiers, parallel digital logic and is designed for expansion with a fast stored-program digital computer. It features what EAI considers to be a breakthrough in amplifier design in both dynamic accuracy and speed. The amplifiers are usable at full amplitude within their 500-kc bandwidth; linear component static accuracy is 0.01%. Accuracy for multipliers is typically 0.015%. Other features include microsecond, low-drift electronic mode control and effectively zero temperature coefficient integrating capacitors—eliminating the need for ovens, the firm said.

A more expensive version of the system includes the complete analog computer, fully equipped console, digital linkage and a general-purpose, medium-sized digital computer, according to EAI. Lower-priced systems do not have the digital computer.

Circle No. 160 on Subscriber Service Card

Pulse Generator

Electro-Optical Systems, Inc., is marketing a variable-pulse generator for application in laser Q-spoiling, dielectric testing, Kerr cell photography and pulse network evaluation.

The Model 85 contains dual generators to provide continuously variable pulse widths from 200 nanosecs. to 5 millisecs. Pulse amplitude is nominally 30 kv. Rise-time is 200 nanosecs.; fall-time is 40 nanosecs.

A second unit, the Model 86, is available for researchers requiring an enclosed Kerr cell with one pair of polarizers. Power requirement for both units is 110v ac, 250 watts, ±10%.

Circle No. 161 on Subscriber Service Card

Vacuum Seal

A vacuum seal, designed to allow three full degrees of motion into a vacuum system, has been announced by Materials Research Corp.

The Model V4-115 vacuum feed-through provides full rotational motion, an 8-in. in and out motion and swiveling on a ball joint within a 60-degree cone. All operations are possible at vacuum levels up to 10^{-7} torr without impairing the vacuum level.

Circle No. 162 on Subscriber Service Card

Panoramic Receiver

Applied Technology, Inc., is marketing a broadband electronically swept panoramic receiver, tuning a frequency range of 30 to 1,000 mc.

The RASP-1 covers the range in two simultaneously swept bands of 30 to 250 and 250 to 1,000 mc. Overshoot and ringing are minimized by using a narrow, Gaussian-shaped I-F passband, the firm pointed out. For reception of pulse and other wideband signals, wider I-F and video bandwidths can be provided with the unit.

The device has a typical tangential sensitivity of —108db from 30 to 250 mc and —103db from 205 to 1,000 mc. Dynamic range is 60 db minimum. The unit meets MIL-1-26600 and MIL-1-6181 RFI specifications.

Circle No. 163 on Subscriber Service Card

Bathythermograph

An expendable bathythermograph system for reliable temperature/depth measurements from shipboard is being marketed by The Sippican Corp.

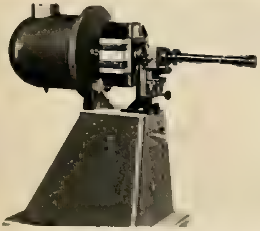
The device is comprised of a simple sensing device (probe), a probe launcher and a data recorder. A continuous 0 to 500-meter temperature/depth profile can be obtained in one minute. Ocean temperatures can be recorded in the range of —2° to 30°C with a system accuracy of ±0.2°C. Measurements can be made at ship's speeds to 30 knots and in sea states from 0 to 5.

Circle No. 164 on Subscriber Service Card

Neutron Generator

A neutron generator capable of producing 14 Mev neutrons at a rate of over 2.5 x 10^{11} n/second has been announced by Technical Measurement Corp.

The Activatron 211 reaches rated yield within 30 seconds after a cold start; beam current stability is better than ±3% per hour. Operating flexibility is achieved through the use of a dual-power sputter ion pump, a variable-focus beam and separately adjustable power supplies for the main accelerator, ion source and focusing sections.



The device consists of an accelerator unit, associated high-voltage supplies and a desk-type control console.

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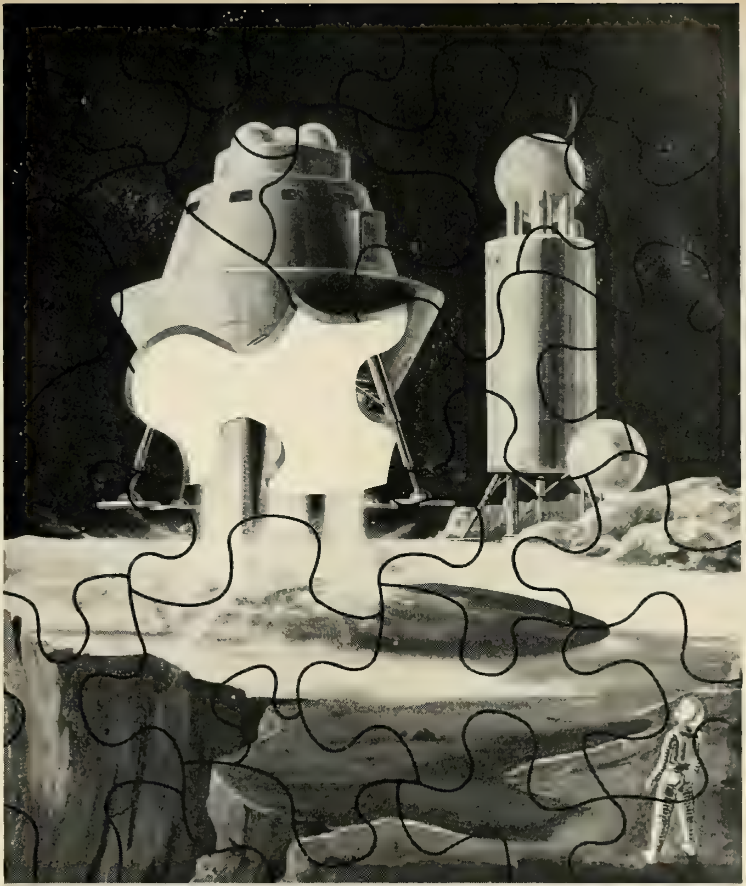

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names in the news

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Joseph G. Bacsik: Elected corporate controller of Ling-Temco-Vought, Inc. He has been with the company for 24 years.

Richard A. Davidson: Named manager of the newly formed electronic imaging systems department of Electro-Optical Systems, Inc. He will be responsible for development of electronic imaging and video signal processing systems and equipment for military and space programs.

Paul Grosher: Named director of programs administration at Space Ordnance Systems, Inc. Also promoted within the organization were **William J. Carrigan,** to executive vice president, and **J. M. Jones,** to director of quality assurance.

Dr. Raymond C. Sangster: Appointed director of research at General Telephone and Electronics Corp.'s GT&E Laboratories. He was formerly director of Semiconductor Exploration Laboratory of Texas Instruments, Inc.

William T. Welsh and Mike W. Fossier: Elected vice presidents of Raytheon Co. Welsh was promoted to the position of vice president-government marketing, and Fossier to vice president and division assistant general manager-technical.

Geoffrey Parsons: Named vice president and European representative of Northrop Corp. **Gwynn Robinson** has been appointed to succeed him as vice president and manager of European operations.

David Shore: Appointed chief engineer of the Engineering Dept. of Communications Systems Div., Radio Corp. of America.

L. T. Ashlock: Elected a national director of the Society of Aerospace Materials and Process Engineers (SAMPE). He is with General Electric Co.'s Silicone Products Dept.

Norman W. Schaum: Promoted to chief engineer of Emco Systems, Inc. He was previously a senior project engineer.

Vito L. Salerno: Appointed to the board of directors of U.S. Components, Inc. He is technical director of a nuclear components research and development facility and consultant to NASA, the Defense Department and many industrial companies.

Dr. Ralph S. Cooper: Named head of the nuclear laboratory at the Donald W. Douglas Laboratories, which will be constructed at Richland, Wash. The laboratory is to be a division of Douglas Aircraft Co.

Donald Pahl: Joined Rocket Research Corp. as senior research engineer. He was formerly with The Boeing Co.

Dr. Charles R. Boyd, Jr.: Appointed manager of the microwave solid-state department for Rantec Corp. He will be responsible for development of such devices as microwave ferrite switches, modulators, microwave integrated circuits and other solid-state electronics used in the space program.

Wendell F. Moore: To be presented the John Price Wetherill Medal of The Franklin Institute Oct. 20 at Medal Day ceremonies in Philadelphia. He is the inventor of the rocket belt capable of lifting a man to an altitude of 60 ft. and propelling him at speeds up to 60 mph.

Sheldon E. Young: Named president of Vibro Dynamics Corp., a newly-formed company specializing in the design and manufacture of vibration control devices.

Henry L. Kaminski: Named manager of manufacturing engineering of the Bendix Products Aerospace Div.

Herbert G. Denaci: Appointed manager of the missile engineering section at Maxson Electronics Div. of Maxson Electronics Corp.

Chauncey P. Dewey, Jr.: Appointed fleet ballistic missile programs manager for Raytheon Co.'s Space and Information Systems Div.

Craig W. Hayes: Joined Space Ordnance Systems, Inc., as manager of operations. In this newly-created position he will be responsible for administration, direction of engineering, contracts, manufacturing and quality assurance activities for the manufacture of electro-explosive and propellant-actuated devices and systems.

William E. Standring, Jr.: Appointed director of the newly-formed components engineering and manufacturing department at Optics Technology, Inc.

—when and where—

SEPTEMBER

Thirteenth Annual Joint Engineering Management Conference, sponsored by American Institute of Aeronautics and Astronautics (AIAA), Institute of Electrical and Electronics Engineers (IEEE), American Society of Mechanical Engineers (ASME), and others, Roosevelt Hotel, New York City, Sept. 13-14.

Thermophysics Specialist Conference, sponsored by AIAA, NASA, National Bureau of Standards, and Air Force, U.S. Naval Postgraduate School, Monterey, Calif., Sept. 13-15.

Electrical Insulation Conference, sponsored by U.S. Navy Bureau of Ships and Allis-Chalmers Mfg. Co., New York Hilton, New York City, Sept. 13-16.

Symposium on Structural Adhesives Bonding, sponsored by Picatinny Arsenal (U.S. Army Munitions Command), Stevens Institute of Technology, Hoboken, N.J., Sept. 14-16.

Advanced Incentive Contracting, sponsored by National Defense Education Institute (NDEI), Washington, D.C., Sept. 15-17.

Astrodynamics Specialist Conference, sponsored by AIAA and Institute of Navigation, U.S. Naval Postgraduate School, Monterey, Calif., Sept. 16-17.

National Power Conference, sponsored by IEEE and ASME, Sheraton-Ten Eyck Hotel, Albany, N.Y., Sept. 19-22.

Fifth Annual National Conference on Environmental Effects on Aircraft and Propulsion Systems, sponsored by U.S. Naval Air Turbine Test Station, Nassau Inn, Princeton, N.J., Sept. 20-22.

Systems Engineering Exposition and Conference, McCormick Place, Chicago, Sept. 20-23.

nternational Conference on Thermionic Electrical Power Generation, sponsored by Institution of Electrical Engineers, London, Sept. 20-24.

Advanced Incentive Contracting, sponsored by NDEI, Los Angeles, Sept. 21-23.

Fifth Annual Bio-Environmental Engineering Symposium, sponsored by the USAF School of Aerospace Medicine, Brooks AFB, Tex., Sept. 21-24.

965 IEEE Conference on Military Electronics (MIL-E-CON 9), Washington Hilton Hotel, Washington, D.C., Sept. 22-24.

3th Annual Communications Conference, sponsored by IEEE, Cedar Rapids, Iowa, Sept. 24-25.

Advanced Incentive Contracting, sponsored by NDEI, New York City, Sept. 28-30.

econd International Congress on Experimental Mechanics, sponsored by Society for Experimental Stress Analysis, International Inn, Washington, D.C., Sept. 28-Oct. 1.

965 Fall National Symposium of the Society for Information Display, Commodore Hotel, New York City, Sept. 29-30.

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Wheeler and the Dealer

FINAL OUTCOME of the American commitment in the Pacific is too important to permit us to look upon the Viet-Nam war as simply a test of the policies and theories of the present U.S. Secretary of Defense. Yet, since the business of the Pentagon is to wage war when it becomes necessary, the question of how well we are doing in combat in Southeast Asia is a crucial one in objectively evaluating the management performance of Secretary Robert S. McNamara.

It is doubly important to this industry, which is so deeply affected by Pentagon policy and upon which the nation depends so heavily for the products and technologies to keep us ahead of the enemy.

Technological superiority does, indeed, lead to military superiority and there are many in the past five years who have questioned what the policies of the current Secretary of Defense are doing to that technological superiority. There are many who have charged that the Pentagon was becoming efficient in almost every business but the business of how to fight a war.

Viet-Nam, therefore, must be regarded as a critical test of the McNamara philosophy of managing the Pentagon. It must take its place alongside the standards of cost effectiveness, program definition, program packaging and others. Viet-Nam performance must indeed be given a greater weight than these others, which all should lead to greater battlefield effectiveness.

Viet-Nam is a cruel test—one of the dirtiest, most frustrating conflicts in which this nation has ever engaged. But this does not make it any less a fair test.

To say that we have to fight it without some of the limited-warfare equipment our forces in the field would like to have is no defense—for we have said before that one of Mr. McNamara's faults was his failure to realize that he has to fight today's war with today's equipment, not something still under development. Certainly, Army fliers in Viet-Nam would like to have the Advanced Aerial Fire-Support System (AAFSS). But it still is in the Pentagon selection machinery and the time to speed it up was several years ago. Navy pilots might like to have the COIN airplane, but it is not yet in production, although it could have been.

Some of the new air-to-ground missile developments would be welcome also, but they still are in the program definition stage.

There is a shortage of the effective Douglas A-1 aircraft, but Secretary McNamara vetoed as too costly a plan unanimously approved by the Joint Chiefs of Staff to re-open the production line early this year

This is a time when that little percentage of improvement in an existing weapon that was ruled out as costing too much becomes critical. There is no economy in eliminating a 1% improvement in the name of cost effectiveness if that 1% permits you to kill the enemy before he kills you. This is a fact of life Pentagon management does not appear to have understood too clearly in the past five years.

This is a time when lack of suitable aircraft forces the questionable use of B-52s at a million dollars a raid to chop Viet Cong firewood, leaving Air Force chiefs in a quandary as to whether to protest the inanity or to accept the fact and use it as proof of the need for a B-52 follow-on.

In the light of all of this, the gentle prodding of the Pentagon's civilian management by Gen. Earle G. Wheeler, chairman of the Joint Chiefs of Staff, in a recent speech should have been even stronger. Gen. Wheeler, addressing an Armed Forces Management Assn. meeting in Washington, said:

"Our armed forces operate on a world-wide basis. Their operations have been successful in the past because commanders exercised command freely on the spot and not with their hands tied by bonds of management directives woven by theorists at higher headquarters."

He left little doubt as to what higher headquarters he meant as he went on to point out the dangers of "overcontrol and overmanagement" of the nation's military by its civilian managers, which he said he has encountered at various Pentagon levels.

Mr. McNamara could not have failed to recognize the implication when Gen. Wheeler stated: "Particularly prone to overmanagement tendencies are those who tend to equate the Department of Defense with any business."

"Finally, and most important," Gen. Wheeler declared, "the manager must remember just what kind of support he is expected to give the commander—quality equipment and personnel, delivered on time to permit accomplishment of the mission concerned. This objective can only be attained to the degree that management goals are co-ordinated with operational plans. The managers do not make these plans, but the plans do 'make' the managers if the management task is properly performed."

GEN. WHEELER, acknowledging the soundness of the system, perhaps was not as blunt as he might have been, for obvious reasons. But his point was made. Commanders in the field, in some cases, are receiving from civilian chiefs at home unneeded and inexperienced advice instead of the equipment they need to carry out their mission. The system may be sound, but its performance is in question.

Any evaluation of Mr. McNamara's Pentagon management at this point must agree with Mr. Charles J. V. Murphy's report from Viet-Nam in the August issue of *Fortune*: "Although McNamara has demonstrated his ability as an administrator of a vast bureaucracy, the primary job of the Pentagon is to conduct war—and the only war McNamara has so far been called upon to conduct has gone very badly from the outset."

William J. Coughlin

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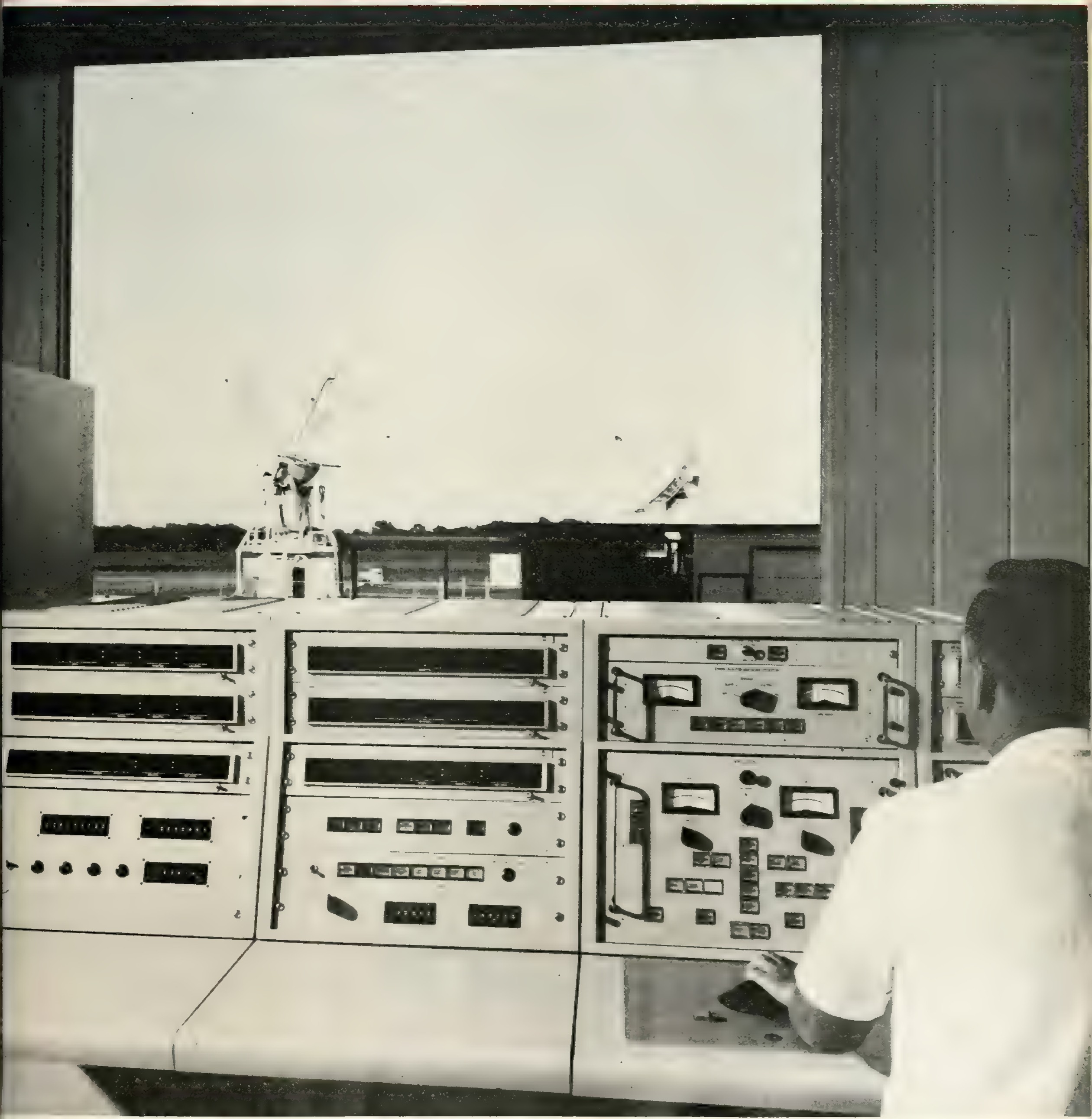

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Openings now on MOL and other challenging programs such as Nimbus, OAO, and Gravity Gradient Stabilization System:

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Interpret satellite systems design and operational mission requirements. Identify and analyze performance parameters and assess their influence on the vehicle system. Perform design trade-off analyses and prescribe acceptable systems behavior, operating domains, tolerances and performance variations. Develop the analytical facility to implement systems synthesis and optimization and evaluate development progress, malfunction, reliability, effectiveness, vulnerability and capability of the vehicle systems. Requires BS/MS EE, ME or Physics and broad understanding of missile/spacecraft subsystems.

INFRARED AND OPTICS SPECIALIST
Responsible for originating, integrating and presenting technical studies of a systems analysis nature. Plan and direct experimental programs to validate new systems and subsystems concepts. Interpret the tactical and strategic technical requirements of the customer in the IR/Optical area. Requires MS/PhD in Physics and broad systems experience in IR and/or optics instrumentation.

ELECTRICAL SUBSYSTEMS ENGINEERS
Responsible for the design, development testing and qualification of the assigned Spacecraft Electrical Subsystem, including all components. Emphasis is on airborne control for the electrical distribution in a space vehicle, including electrical power and signal distribution for AGE. Requires BSEE with minimum of 4 years' applicable experience.

RELIABILITY ENGINEERS
Individuals will be responsible for determining reliability requirements on assigned programs, to include: design, reliability; failure mode and effects; system and component analysis; test design and evaluation; failure analysis; maintainability; risk assessment; cost analysis and vendor reliability. Requires BSEE or Physics and 3 to 5 years' applicable experience.

ENGINEERS — SYSTEMS EFFECTIVENESS
Establish systems effectiveness criteria for manual space systems. Study and assess systems and mission data; interpret customer effectiveness directives; devise and specify figures of merit and accountable factors; estimate parameters; and set preliminary contractual effects. Experience required in operations analysis, system analysis, mission analysis, probability theory and reliability.

SYSTEMS ENGINEERS — ELECTRICAL
To lead and perform studies of electrical systems for spacecraft auxiliary power and propulsion. Included here is the definition of systems requirements, determination of system characteristics, performance optimizations, and evaluation of the state-of-the-art in the areas of power conditioning equipment (static switching circuits, transformer design, etc.), alternators, E-M pump technology, control systems, electrical power transmission, and electronic payload equipment. A broad range of experience in electrical power systems and analog simulation is desired, with proven analytical ability, and skill in communicating (written and oral presentations).

GUIDANCE AND CONTROL SYSTEMS ENGINEERS
Conceive and conduct analytical studies resulting in the design and development of sophisticated systems for the navigation, guidance and control of Space Vehicles. Both active and passive techniques are currently under study and development for the control of Orbiting Spacecraft, rendezvous techniques, interplanetary flight and specialized military systems. Requires BSEE, ME or Physics. Intermediate and senior positions.

ENGINEERS — THERMODYNAMICS
Responsible for the design adequacy of orbital and re-entry space vehicles with respect to thermodynamics, heat transfer and aerodynamic heating factors. Will engage in synthesis and parametric studies pertaining to configuration heat protection system performances and internal cooling system performance. Requires MSME, AE or Chemical Engineering with 2 to 6 years' aerospace experience.

OPERATIONS ANALYSIS ENGINEERS
3 to 10 years' experience in space vehicle systems design, development, test and operations. Emphasis on hardware knowledge, systems integration and data analysis. Must be interested in responsible assignment and customer contact. Assignment is in technical support of military space programs.

PROJECT ENGINEERS
Responsible for technical direction of all work on assigned programs. This includes interpreting customer requirements, technical integration, establishing program direction and funding, and measurement of progress. Requires engineering degree, strong administrative capability and a thorough knowledge of engineering, manufacturing and quality control.

ENGINEERS — COMMAND & TELEMETRY DESIGN
Responsible for the design of new spacecraft components from conceptual phase through detailed design, production, test and use. Includes airborne and ground telemetry, voice and video circuitry and sensor components. Requires comprehension of analog and digital circuitry, receiver and transmitter design experience and a knowledge of microelectronics. BS/MSEE or Physics with minimum of 4 years' experience.

ENGINEERS — GROUND SUPPORT EQUIPMENT
Design and development of checkout, handling, transport, acquisition display, and control equipment for orbiting spacecraft. Assignments include: thermal control equipment; propulsion system checkout; life support equipment; assembly alignment and transport equipment; sensing, control, acquisition and conditioning equipment; and special test support equipment. Requires technical degree plus 6-10 years' aerospace experience.

ENGINEERS — SIMULATION
Responsible for analysis specifications, monitoring and evaluation of crew equipment and simulation systems design from the conceptual to operable stage. Will develop simulation test plans, implement their operation and evaluate resultant data. Provide thermal control systems engineering, training systems engineering, and crew operations integration. Knowledge of software simulation systems and programming and operation of analog/digital computers. Engineering degree plus 4-6 years' applicable experience required.

HUMAN FACTORS PSYCHOLOGISTS
Human factors analysis of AGE, AVE, and crew accommodation equipment for manned space vehicles. Evaluation of adequacy of design as regards reliability, safety, service and maintenance. Determine optimal work-place layout, displays and controls requirements, lighting conditions and support-restraint devices. Establish training and simulation requirements and define spacecraft checkout interface. Relate anthropometric, pressure suit and restraint data to determination of crew visual-manual function envelope. Requires BS/MS Psychology or Engineering and 4-8 years' aircraft and/or space vehicle experience.

ENGINEERS — LIFE SUPPORT SYSTEMS
Analysis, design, development, test and evaluation of life support equipment which will enable men to perform in space for extended periods of time. Subsystems include cabin pressure control, thermal control, pressure suit, support equipment, waste collection and personal hygiene, safety and survival. Requires technical degree and direct comparable experience.

SURVIVABILITY SYSTEMS ENGINEERS
Plan, direct and contribute to survivability studies of advanced space systems subject to natural and man-made radiation environment. Efforts include: design and circuit analyses of transient radiation effects on electronic systems; design and conduction of radiation tests on components and subsystems; analysis of the generation mechanism, transmission and interaction of various forms of energy from a nuclear weapon. Requires BS/MS EE, ME, or Physics with several years of experience in either circuit design, electronic hardening techniques and a familiarity with nuclear weapons technology.

You are invited to inquire further by writing to: Mr. J. S. Barson, Room 394J-3.
Valley Forge Space Technology Center, General Electric Co., P.O. Box 8555, Philadelphia, Pennsylvania.

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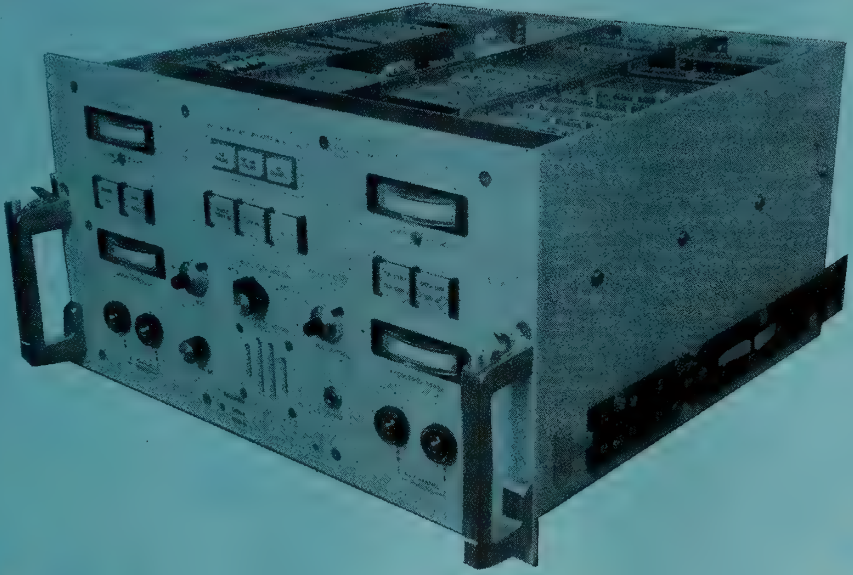

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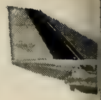
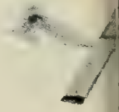
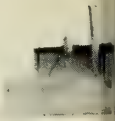
Lockheed engineers and scientists have designed a fixed-wing supersonic transport which will cross the Atlantic or Pacific in less than half the time now possible with present subsonic jets.



Lockheed engineers and scientists have designed and developed a rigid rotor compound helicopter which recently flew 272 miles-per-hour.



Lockheed engineers and scientists have designed and developed a hydro-ski assault craft—test bed for a proposed 70 mile-per-hour landing craft that would skim smoothly over the water and rush combat troops to the beaches, 60 miles per hour faster than is possible today.



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missiles and rockets
THE WEEKLY OF ADVANCED TECHNOLOGY

Volume 17, Number 12 September 20, 1965

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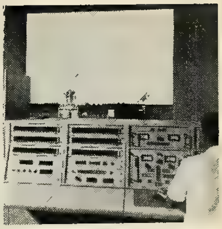
THE COVER



NASA's unified S-band Apollo communications/tracking system was demonstrated to the press for the first time last week by developer Collins Radio Co. A 30-ft. dish for the system can be seen in left background, through window, and operator is at antenna control console. See p. 34.

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letters

Soundings

To the Editor:

Your "Special Report: Oceanology" (M/R, Sept. 6) issue was one of the most interesting, informative and educational to be published in recent months. Most of the advertisements were spectacular, providing considerable new data on oceanology.

I enjoyed John F. Judge's "Hull Development Paces Exploration"—especially the photo of the Aluminaut's interior and the "Operating Depth Potentials for Hulls of Various Materials" prepared by Martin A. Krenzke. Mr. Judge's discussion on the use of glass for future submersibles was revealing.

Mr. Charles D. LaFond's "Industry Struggles to Meet Demand" was also informative, providing statistics on the Advanced Manned United States Submersibles which would be difficult to obtain through individual research.

BUT WHY DID YOU OMIT THE ALVIN STORY?

The Aluminaut was given thousands of words of publicity even though, as of the end of August, according to Mr. LaFond, she had only descended to 2,700 ft., less than one fifth her 15,000-ft. design depth.

Alvin, however, has made more than 100 successful dives, and on July 21, 1965, with two men aboard, off the Andros Island, made a highly successful dive to her maximum design depth of 6,000 ft.

Mr. Michael Getler in his article "Lack of Definition Slows Progress" quotes Allyn Vine, Woods Hole Oceanographic Institute's staff scientist, after whom Alvin was named; and Alvin is listed in the chart "Advanced Manned United States Submersibles" as having a 6,000-ft. diving depth and that she is operational. Your staff, therefore, should have been aware of Alvin, the world's first deep-diving submarine.

Larry Megow
Houston

No slight was intended in minimizing text for the Alvin deep-diving submersible. Since space was at a premium and because Alvin is an operational vehicle, it was felt that readers would benefit more through description of newer vehicles currently planned or in development. As for the Aluminaut, it must be remembered that the vehicle is still undergoing a carefully planned test program. Dives are progressing deeper and deeper in increments of 500 ft. Safety is considered paramount by Reynolds and great care is being taken to obtain strain-gage measurements throughout each dive. Barring unforeseen problems, developers still believe the 15,000-ft. maximum operating depth will be reached by early 1966.—Ed.

To the Editor:

The lack of reliability in oceanological instrumentation reported in MISSILES AND ROCKETS, Sept. 6, 1965, is not surprising in view of the lack of participation in the development thereof by non-academic intuitive inventors with solid patent backgrounds.

In his book, "The Act of Creation," Arthur Koestler narrates: "Max Planck stated that the pioneer scientist must have a vivid intuitive imagination; Faraday was ignorant of mathematics; von Helmholtz admitted that intuition is superior to mathematical analysis; and Edison benefitted from his shocking ignorance of science."

The views expressed in the article "How To Invent" in *International Science and Technology*, February, 1964, are also quite interesting.

A most important consideration in oceanological instrumentation is that of gravitational effects. . . . Metals change in weight because of environmental factors, oxidation, and movement across a point of equilibrium; and such metallic weight variations affect reliability.

Harry Bricker Fuchs
Farmingdale, N.Y.

To the Editor:

I read with interest the recent "Oceanology" issue of MISSILES AND ROCKETS and wanted to congratulate you on the fine reporting job in your article, "Hull Development Paces Exploration."

In fact, I feel that the entire staff should be commended on this issue and the outstanding job that was done in reporting on this exciting new field of exploration.

Reeve K. Biggers
Owens-Corning Fiberglas Corp.
New York City

Static in the Countdown

To the Editor:

Cancellation of the Pan American services contract at Patrick AFB mentioned in the Sept. 6 MISSILES AND ROCKETS Countdown (p. 9) was not the subject of a hearing conducted by the House Armed Services Special Investigations Subcommittee.

The committee did study a DOD directive to consolidate certain supply functions now jointly performed by Pan Am and Air Force personnel at Cape Kennedy and the Air Force Eastern Test Range. Pan Am's Guided Missiles Range Div. is prime contractor at the Eastern Test Range, responsible for operation, maintenance and development of the range.

Hundreds of support functions, including supply, are performed by Pan Am, now in its 13th year of operations at Cape Kennedy. Countdown left the impression that Pan Am's entire services contract was being cancelled, when, in fact, only a small fraction of its total support work is involved in the subcommittee's investigation.

J. F. Fortes
Supervisor, Public Relations
Pan American World Airways, Inc.
Guided Missiles Range Div.

IMPORTANT OPENINGS FOR ENGINEERS AND SCIENTISTS ON AMERICA'S MAJOR SPACE PROGRAMS

On July 1, 1965, TRW Space Technology Laboratories — STL — became TRW Systems. This new name more accurately reflects the expanding nature of our business. Previously, all our work involved the science and technology of missilry and space. But today our business also includes anti-submarine warfare, scientific instrumentation, the application of systems engineering and management concepts to non-defense programs, and the manufacture of components and sub-systems.

These major programs . . .

LEM inertial guidance system
LEM descent engine
Gemini and Apollo mission analysis
OGO satellites
Advanced ballistic missile studies
Underwater defense systems
Pioneer interplanetary spacecraft
Communications Satellites
Advanced space probes
Vela nuclear detection satellites
Mars mission studies

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The Countdown

WASHINGTON

AF Thinks Gemini-X Restricts MOL

Now that the *MOL* program is off and running, Air Force planners would like to see a parallel program to develop a hypersonic maneuvering re-entry vehicle to replace the *Gemini-X* atop *MOL* after completion of the planned *MOL* flights. While chances of approval for such a program appear slim now, backers nevertheless can be expected to push for it on an informal basis. Big point with the military is that while ballistic recovery may be adequate for civilian space flights, the ability to select numerous landing sites from any orbit would add greatly to U.S. space capability.

NASA Asks for Additional Astronauts . . .

The space agency expects to add as many as 15 new astronauts to the present pool of 28 pilot-astronauts and five scientist-astronauts. Applications must be received by Dec. 1. Each applicant must be a U.S. citizen, be no taller than six feet and no older than 36.

. . . and Plans Stringent Apollo Checkout

Delivery of an *Apollo* spacecraft to NASA's Manned Spacecraft Center is expected late this year or early next year to begin overall Command and Service Module spacecraft systems tests in the center's $40-million space simulation chambers. Chamber A—120 ft. high, 65 ft. in diameter and capable of simulating 87-mi. altitudes—is equipped with solar panels and liquid nitrogen cold walls. Chamber B—43 ft. high and 35 ft. in diameter—will be used for astronaut training and will hold either a Command Module or a Lunar Excursion Module. Chamber B is undergoing final checkout and is expected to become operational in a few months.

Gemini 5 Difficulties Tentatively Diagnosed

Post-flight analysis of the *Gemini 5* spacecraft re-entry module has led NASA officials to believe that failure of the fuel cell liquid oxygen reactant supply heater occurred in the adapter section, which was jettisoned shortly before re-entry. Meanwhile, *Gemini 6* Command Pilot Walter Schirra said during a recent press conference that inability of the *Gemini 5* radar to display range-rate information has been attributed to a faulty capacitor, which fouled radar circuitry.

NASA Interested in Balky Aquanauts

Reports that aquanauts participating in the Sealab II exercise have become a bit recalcitrant toward the end of their 15-day sojourns in the sea are being closely watched by NASA. Some of the same independence was reported during the Sealab I experiment last year. With similar conditions of confinement and stress of a new environment to be faced on long space flights, manned spaceflight experts and psychologists are looking at the data with considerable interest.

Committee Shelves Weights, Measures Bill

A bill to set up a three-year study of the feasibility of converting the U.S. system of weights and measures to the metric system has been stalled for at least a year. Although voted out by the House Science and Astronautics Committee, the House Rules Committee, chaired by octogenarian Rep. Howard Smith (D-Va.), voted not to allow the bill to reach a vote this session.

INDUSTRY

Big Solid Firing Set for Sept. 25

Firing of Aerojet-General's 260-in.-dia. solid motor is now scheduled for Sept. 25. The 80-ft.-long motor will be fired for the full two-minute duration and is expected to produce a thrust of 3.5 million lbs. The test will take place at the firm's Dade County, Fla., facility, which was effectively battened down against Hurricane Betsy.

Shirtsleeve GT-7 Decision Still Pending

The decision on shirtsleeve flight wear for the *Gemini 7* mission pilots is awaiting outcome of manned spacecraft altitude chamber tests at McDonnell Aircraft Corp., St. Louis. Astronauts Frank Borman and James Lovell, wearing the lightweight one-piece garment (including helmet) were expected to make a four-hour run in the chamber at a simulated 150,000-ft. altitude. In a second manned test, backup pilots Edward White and Michael Collins were to wear standard *Gemini* spacesuits. Purpose of the altitude chamber tests is to check out the spacecraft environmental control system (ECS).

MOL Contractor Responsibility Clouded

Representatives of Douglas Aircraft Co. and General Electric Co. continue to hammer out *MOL* program details with officials of Air Force Space Systems Div. in sessions that began Labor Day. The meetings are believed to be aimed at defining work packages for the two chief contractors. Difficulty involved is that contract awards—to Douglas for hardware and GE for experiments—cut sharply across proposal lines and have forced Air Force to start from scratch in defining contractor responsibilities.

INTERNATIONAL

Reorganization Reflects French Missile Emphasis

The continuing sophistication of the French missile/space effort is evident in the reorganization of the French Armament Administration (Délégation Ministérielle pour l'Armement) undertaken last month. In it, missiles have come of age as a major branch of the organization. Head of the new Missiles Department (Direction Technique des Engins), is Gen. Engineer (Air) Pierre Soufflet. His department will also be in charge of military activities associated with space work.

Goddard Receives First French Satellite

The first French-built satellite, *FR-1*, arrived last week at Goddard Space Flight Center for testing, enroute to Ling-Temco-Vought in Dallas for adaptation to a *Scout* launch vehicle. When tests are completed, the prototype will go back to France to serve as a construction model for the *FR-1* program. The first *FR-1* is scheduled to be launched later this year on a *Scout* from Vandenberg AFB.

Germans Returning for Pershing Training

The first German Air Force missile group to return to the U.S. for additional training is scheduled to arrive at White Sands Missile Range, N.M., Oct. 1 for further firings of the *Pershing* missile. Some 50 officers and enlisted men will participate in the first annual exercise firing of the *Pershing* from Gilson Butte, about 40 mi. southwest of Green River, Utah, into an impact area at WSMR.

The Missile/Space Week

Titan III-C Launch Date Shifts

The Air Force now plans to launch the second *Titan III-C* October 7th from Cape Kennedy instead of the original date of September 30.

The shift is due to test interruptions caused by Hurricane Betsy. There have not been any reports of damage to the launch complex or to the vehicle, but certain ground tests and associated equipment were affected by the hurricane.

John S. Foster New DDR&E

Dr. John S. Foster, Jr., recently named Director of Defense Research and Engineering, plans to spend the next few months assessing the problems facing his organization.

Foster, formerly head of the Atomic Energy Commission's Lawrence Radiation Laboratory in Livermore, Calif., will replace Dr. Harold Brown, who becomes Secretary of the Air Force on Oct. 1 (M/R, Sept. 13, p. 14).

Foster told MISSILES AND ROCKETS that President Johnson, Defense Secretary McNamara and Dr. Brown have urged him to spend several months getting a grasp of the problems.

However, there are certain obvious problems which must be faced, he said. These include the continuing requirement to be absolutely sure of our deterrent; the need for an adequate ballistic missile defense system and efficient application of the nation's R&D resources to meet "our tremendous commitment in South Vietnam," Foster said.

Raytheon Aims at 407L Job

Raytheon Co. has formed a team to bid on the Air Force's 407L Tactical Air Control System. Linked with Raytheon are: Burroughs Corp., data processing; Electronic Communications, Inc., communications sub-systems; and Planning Research Corp., for software and trade-off analysis.

Five other firms are also bidding on the program, which has an estimated value in excess of $200 million (M/R, March 29, p. 114). The other firms include: Hughes Aircraft Co., Litton Industries, the Nortronics Div. of Northrop Corp., General Electric, Westinghouse Electric Corp., and Sperry Rand Corp.

Bids are expected to be in before the end of the month, and the Air Force reportedly will select two or more contractors to begin formal definition studies in October. 407L hopefully will evolve into a highly mobile, air-transportable tactical communications and command system, something which has eluded the service thus far.

Sterilization Conference

NASA's Jet Propulsion Laboratory and the California Institute of Technology will sponsor a National Conference on Spacecraft Sterilization Technology in Pasadena, Calif., Nov. 16-18.

Five sessions are planned covering sterilization requirements; control of microbiological contamination; microbiological decontamination and sterilization; sterilizable capsule components and subsystems; and capsule structures and payloads, procedures and facilities.

NASA speakers will include Homer E. Newell, associate administrator for space science and applications, and William H. Pickering, director of JPL.

The meeting is the first in a planned series of annual conferences dealing with sterilization of planetary landing capsules.

Hagerty Named NASA Aid

William W. Hagerty has been named consultant to NASA Administrator James E. Webb in the area of university-industry relations.

Dr. Hagerty is president of Drexel Institute of Technology in Philadelphia. Previously, he served on the faculties of the Universities of Cincinnati, Michigan, Delaware and Texas.

SNAP-25 Negotiations Off

The Atomic Energy Commission has broken off contract negotiations with Lockheed Missiles and Space Co. on the development of SNAP-25, a 75-watt isotopic device.

The cancellation of the program also affects Nuclear Materials & Equipment Corp., Apollo, Pa., and RCA's Electronic Components and Devices Div., Harrison, N.J., joint bid members with Lockheed on the $5.75-million development program.

The AEC's reason is that the SNAP-25 system essentially duplicates the technology of SNAP-27, a 50-watt plutonium-238 generator. The AEC is negotiating a development contract with General Electric for the SNAP-27 with the award expected before the end of this month.

SNAP-27 may fit certain power needs on the *Surveyor* in the Lunar Surface Advanced Application Program and would be used in addition to the SNAP-11 generator to provide 25 watts to *Surveyor* under lunar night conditions.

Soviet Says Moon Core Hot

A theory that the interior of the Moon may be four or five times as radioactive as the interior of Earth has been advanced by a Soviet scientist.

According to Dr. V. S. Troitsky of the Scientific Research Radiophysics Institute in Gorky, radio emissions from the Moon indicate that its interior has an intense heat, suggesting a radioactive core. Attending a U.S.-USSR conference last week on bodies of the solar system, Troitsky said that the radio observations also indicated a surface layer of light material roughly 20 ft. thick, overlying denser rock.

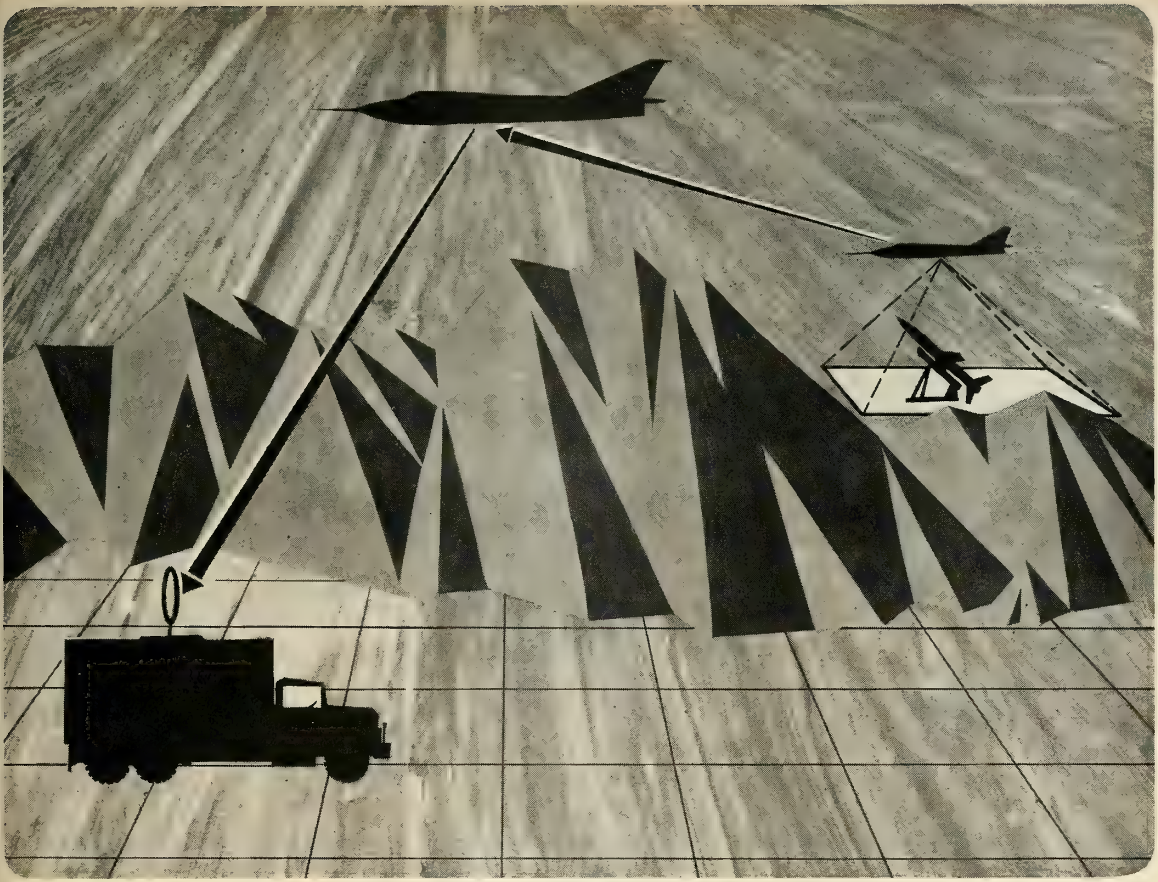
Weather Control Urged

Technological advances in the past decade, including high-speed electronic computer simulation of the atmosphere and new capabilities for observing weather phenomena, have brought scientists to the conviction that a program of weather modification should be undertaken, Secretary of Commerce John T. Connor has told President Johnson in an official memorandum.

Connor also praised the work of the meteorological satellite thus far in aiding forecasts of Hurricane Betsy and as the heart of the World Weather Watch program (see photos, p. 18).

The Commerce Secretary said that a vigorous national program should be mounted to explore the possibilities of weather modification, and that he intended to have the newly created Environmental Science Services Administration take a leading role in the program.

Such a national program will require additional resources to provide necessary facilities for conduct of large-scale field research experiments, Connor said. The Chief of the Weather Bureau has already received a special report on weather modification, dealing with the scientific, social, economic, legal and legislative aspects of the subject. Other reports, by a special panel of the National



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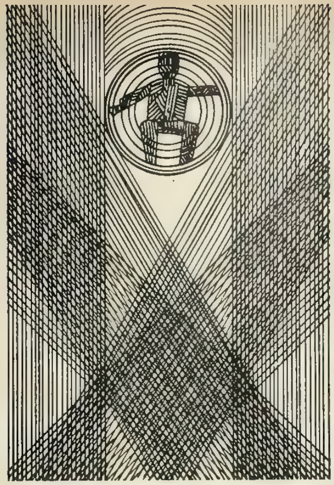

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Academy of Sciences and another by a special commission of the National Science Foundation, are being prepared to help shape an important new Federal research program, Connor said.

Connor said that the development of meteorological satellites by the United States has opened up "radically new opportunities" for the acquisition of weather data on a global scale and for international weather cooperation. The development is of such "basic and far-reaching importance," he said, that the Environmental Science Services Administration and NASA are exerting every effort to perfect this platform.

While the development of the *Tiros Operational Satellite* (*TOS*) System will be a "huge stride forward," he said, it is only a beginning.

Tracking Ships Grounded

Two ships being supplied by the Navy to Ling-Temco-Vought, Inc., for modification as NASA *Apollo* range tracking ships (p. 34) were driven aground near New Orleans during the recent Hurricane Betsy.

The USS Huntsville and USS Watertown were essentially hulls, having been stripped recently in preparation for installation of equipment and modification as range tracking ships. Both ships are scheduled to receive the new Unified S-Band electronics equipment.

Capt. A. F. Hancock of the Navy's Integrated Ships Program Office reported extensive structural damage to the Huntsville and somewhat less damage to the Watertown and the extent of bottom damage has not yet been determined for either ship. Navy estimates indicate it will take 10-14 days to refloat both ships. Navy salvage teams are now working to free the vessels.

Hancock indicated that unless extensive bottom damage has occurred, repair should not significantly delay completion dates on the two ships since LTV, the instrumentation contractor, can perform its work concurrently with the hull repair on the two ships.

Shots of the Week

NASA, Argentine, Brazilian, U.S. Weather Bureau and Naval Ordnance Lab personnel launched 15 *Arcas* and *Hasp* rockets from Wallops Station, Va., Sept. 8-10 in the first exercise of the recently formed Inter-American Experimental Meteorological Rocket Network. The firings took place over a 39-hour period ending the morning of Sept. 10. The rockets gathered information on daily variations of wind and temperature and estimated solar radiation for correction needed for future meteorological rocket payloads. They were fired to altitudes up to 180,000 ft. during local sunset, midnight, sunrise and noon.

- The Soviet Union on Sept. 9 launched the 85th satellite in the *Cosmos* series.
- The Air Force launched a *Thor*-Altair booster combination from Vandenberg, AFB, Calif., on Sept. 10, presumably on a high-acceleration re-entry vehicle test. The payload was to have impacted 5,000 mi. down the Western Test Range.
- The Army on Sept. 13 announced that it has successfully fired the *TOW* anti-tank missile in tests at the Redstone Arsenal, Ala. Center hits were said to have been scored on tank-size targets more than a mile away from the launcher.

Mariner IV Still Useful

Mariner IV continues to transmit useful scientific data to Earth, more than 500 hours after its designed mission lifetime.

The spacecraft, launched Nov. 28, 1964, passed by Mars July 14 and successfully photographed and relayed pictures of the Martian surface. After covering more than 400 million miles in space and now more than 15 million miles beyond Mars, *Mariner IV* continues to report on cosmic dust, magnetic fields encountered in space and interplanetary levels of cosmic rays and radiation. The spacecraft is also reporting engineering data on its own condition as it orbits the Sun.

Phoebus IA Disassembled

Information gleaned during the disassembly of the Phoebus IA nuclear rocket reactor will be applicable to Phoebus IB—due to be tested in 1966.

The Los Alamos Scientific Laboratory reactor was damaged during a design power run on June 25 at the Nuclear Rocket Development Station, Nev. An interruption of coolant flow after the 10.5-minute run ended caused reactor overheating prior to the introduction of emergency gaseous hydrogen coolant.

The nozzle was largely unaffected, but the throat was damaged by the ejection of fuel elements from the central core area. The post-mortem disclosed data on the several experiments on core periphery corrosion originally incorporated into the powerplant.

Logistics Engineering at Boeing

The Boeing Company's Space Division has immediate openings on the Saturn S-1C booster program for experienced logistics engineers and analysts in Huntsville, Alabama and New Orleans, Louisiana. These assignments offer professional scope and challenge, and an opportunity to move ahead in your field.

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Marshall To Do AES Integration

Manned Spacecraft Center's Gemini, Apollo responsibilities prompt change of plans; RFP expected early in October

by Hal Taylor

SPACE AGENCY officials are expected to give the Marshall Space Flight Center responsibility for direction of the payload integration of the *Apollo Extension Systems (AES).*

The selection of Marshall is a switch from earlier plans, which called for the Manned Spacecraft Center to direct the *AES* effort. Top NASA officials now believe, however, that the workload at MSC caused by the *Gemini* and *Apollo* programs will prevent the center from handling *AES* also.

While Marshall is also heavily engaged in the *Apollo* program, officials report that it has a larger capability to take on additional work.

The recommendation for *AES* program management is now in the office of Associate Administrator for Manned Spaceflight George E. Mueller. A final decision is expected by the end of this month.

• **RFP imminent**—As soon as the selection of Marshall is announced, the center will issue a request for proposals to industry calling for program definition of the job of integrating the *AES* spacecraft and its experimental payloads.

Two or three firms will be selected for the first phase, which will last about six months. One of the firms will then be selected next year to serve as prime contractor for *AES.*

Despite its apparent loss of the responsibility of integrating *AES* and its estimated $700-million experimental payloads, MSC will still play a major role in the program. It will be responsible for modifying the *Apollo* spacecraft for the program, detailed program planning and flight control of *AES* missions.

It will also continue to be the most important NASA center in study and development of advanced manned spacecraft, such as the *Manned Orbital Research Laboratory (MORL).*

In modifying the current *Apollo* spacecraft for *AES,* MSC will have to develop three different kinds of spacecraft. One will involve the Command and Service Modules and an orbital laboratory for Earth-orbit and lunar-orbit flights. The other two call for a Lunar Excursion Module (LEM) shelter, which will house astronauts on the lunar surface for up to two weeks and another LEM vehicle that will be used to return the astronauts after the two-week missions.

• **Scope of AES**—The *AES* program now calls for a total of 20 missions, including 45-day Earth-orbital flights, 28-day flights in lunar orbit and the two-week lunar surface operations. Plans call for 16 of the flights to be Earth-orbit missions. Nine of the flights would last 45 days and seven would have a 14-day duration.

Two synchronous flights with the spacecraft at an altitude of 22,300 mi. are on the schedule. All the other Earth-orbital flights, according to preliminary plans, would be made in 200-n.-mi. orbits.

The flight schedule originally called for the first mission to be flown in March, 1968. This may prove to be overly optimistic because of the slippages that usually develop in space programs.

Experiments planned for the first flight in early 1968 include radiation

Soviet Lunar Program Data Scarce at IAF Congress

ATHENS—A sizeable Soviet delegation at the International Astronautical Federation's Congress here had little to say about future Russian plans or progress in the USSR's lunar landing program.

The delegation was led by Academician Leonid Sedov. Soviet papers were concerned largely with minor bioastronautical or astrodynamic problems. Cosmonauts Alexei Leonov and Pavel Belyayev attended, but, beyond public appearances and a chat with Greece's King Constantine, contributed little to the session.

Emphasis in U.S. papers delivered was on uses for Project *Apollo* hardware beyond initial manned lunar landings.

NASA Associate Administrator for Manned Space Flight George E. Mueller told those attending the Sept. 12-18 meeting, "The *Gemini* and *Saturn/Apollo* programs are providing the U.S. with a broad base of technological, managerial and resource capability which makes feasible a wide spectrum of space missions beyond the initial lunar landings."

He said the proposed *Saturn/Apollo* application program now is undergoing preliminary program definition. "In this extension of the *Apollo* program, the basic consideration has been to use present *Apollo* hardware with as little modification as is consistent with the proposed mission under study," Mueller said.

Missions under study, he said, are Earth-orbital, lunar-orbital and lunar surface exploration. The NASA official said Earth-orbital missions include extended durations in low-inclination, polar and synchronous orbits. Flights of up to 28 days in lunar polar orbit and two-man lunar surface missions up to 14 days are possible with the *Apollo/Saturn* hardware, Mueller said.

Marshall Space Flight Center Director Dr. Wernher von Braun also emphasized the future potential of the *Apollo* program, pointing out that it goes beyond the limited goal of a lunar landing. He noted that *Saturn,* in addition to the capability of placing more than 120 tons in Earth orbit, also could propel a 35-ton probe to Mars or Venus.

Robert Sohn of TRW systems requirements staff outlined to the meeting a TRW proposal submitted to NASA last year for a $20-billion to $30-billion program to land a two- or three-man mission on Mars in the 1984 time period employing *Apollo* hardware on a Venus swing-by trajectory. He said this would be possible without the M-2 engine or nuclear propulsion.

American astronauts L. Gordon Cooper and Charles "Pete" Conrad—the *Gemini 5* crew—were to have arrived Sept. 16.

monitoring to provide a record of radiation received by the crew and the external radiation environment, investigations of capillarity studying the interactions of matter at interfaces in free fall and a biomedicine/behavior package assessing the effects of prolonged weightlessness on the crew and microbiological organisms.

While no final decision has been made, informed sources told Missiles and Rockets that Joseph de Fries will be named to head the *AES* work at Marshall.

He is already director of the *AES* program in the center's Advanced Systems Office, and that office is expected to be expanded to handle the *AES* payload integration work. The appointment needs only the final approval of center director Dr. Wernher von Braun before becoming final.

De Fries was born in Germany and came to the U.S. in 1956. He worked for General Electric Co. at Bloomington, Ill., and then joined NASA in 1959. He has served as assistant director of the Aero Astrodynamics Laboratory and chief of the Systems Concept Planning Office. During 1961 and 1962, he was responsible for many of the Marshall studies of the then competing lunar-orbit rendezvous versus Earth-orbit rendezvous concepts for attempting a lunar landing flight.

- **Optics work**—In a related *AES* development, NASA last week announced two contractor teams for optical technology study contracts. Perkin-Elmer Corp.'s Electro-Optical Div. heads one team, assisted by Lockheed Missiles & Space Co. A team headed by Chrysler Corp.'s Space Div. includes Kollsman Instrument Corp. and Sylvania Electric Products, Inc.

Marshall Space Flight Center will negotiate the parallel study contracts for the Office of Advanced Research & Technology. Negotiations will include setting the duration and value of the contracts.

OART currently has $200,000 in FY '65 funds to be split between the two firms, a NASA official said. This money would cover some six months of preliminary work. The plan is for the initial study phase to cover one year and have a total cost of $700,000.

The optical technology program was originally conceived as a separate satellite to be launched unmanned on a *Saturn IB* vehicle. It is now a part of *AES* and work statements have been written accordingly.

Other companies bidding on the study contract were: Grumman Aircraft Engineering Corp.; Raytheon Co.; North American Aviation, Inc.; Martin Co.; American Optical Co.; General Electric Co.; Douglas Aircraft Co., and Hughes Aircraft Co. ■

Radiation-Monitoring Satellite Awaits Titan III-C Launching

by Sue Butler

THE FIRST OF TWO *OV-2* satellites will be launched from Cape Kennedy atop the next *Titan III-C*, officially scheduled for Oct. 7.

Two such satellites, designed to explore, monitor and assess the biological hazards of manned travel through the Van Allen radiation belts, are to be launched in this series. The second in the series is scheduled to be launched in December.

The planned orbit for the *OV-2-1* series is 4,000/400 n. mi., while a near synchronous 18,200 n. mi. orbit is slated for *OV-2-3*. *OV-2-2* was designed but subsequently cancelled as a result of changes in the *Titan III* vehicle's test scheduling.

OV-2-1, made by Northrop Space Laboratories for the Air Force Office of Aerospace Research, will weigh 375 lbs. including experiments. The satellite consists of a rectangular 23 x 24-in. box and contains four solar paddles whose angles can be varied to provide for either solar or random orientation.

- **Stabilization**—The satellite has the capability of being spin-stabilized. Re-spinning in case of slowdown is made possible through use of ammonium hydrosulphide, a solid that becomes gaseous at 70°F. The one pound of gas is fed through a valve and releases the 6.7 psi equilibrium pressure. The re-spinning system probably will not be needed, according to Lt. Col. A. F. Williams of OAR, but has been accepted as an additional experiment. Payload capability is 129 lbs.

The solar paddles are folded down on launch and are spun up by rockets on each of six booms at about 10 rpm. The satellite will be separated rearward from the *Titan III* transtage after a third burn over Baja California, Mexico.

The power supply for the experiments on *OV-2-1* will be 40 w, 33% shadow time, and 30% duty cycle. Radio frequency subsystems consist of receivers, transmitters, beacons, and antennas, and are designed for use with the Air Force Satellite Control Facility. The command subsystem is designed around the particular tracking network and the control requirements of the onboard instrumentation. *OV-2-1* uses seven one-tone commands and three stored commands.

The *OV-2-3* is designed for use with the Air Force National Range and will use six-tone binary coded words. Total command capability is 63. It will be Sun-oriented and spinning. The experiment power will be 72 w, no shadow, and 25% duty cycle.

The *OV-2-1* satellite, which will explore the hazards of the charged particle environment in the near-Earth regions of space, will contain 14 experiments furnished by OAR, Air Force Cambridge Research Laboratories, Cambridge, Mass., and the Air Force Weapons Laboratory at Kirtland AFB, N.M.

- **Experiments**—Instrumentation on the satellites will include:

—Directional particle detector, which will measure directional fluxes and spectra of protons from 0.07 to 70 mev, and of electrons from 0.07 to 6 mev;

—Omnidirectional proton spectrometer, which will measure the omnidirectional flux and spectra of protons and electrons;

—Faraday cup, which will measure electron and proton fluxes from several to 20 mev;

—Cerenkov counter to measure proton directional fluxes;

—Flux gage/search coil magnetometer, which provides spacecraft orientation relative to the Earth's magnetic field;

—VLF receiver to provide information on low-frequency fluctuations of the geomagnetic field;

—Plasma probe to measure energetic particle density;

—Electrostatic analyzer, which senses unidirectional flux of low-energy electrons and protons;

—Proton detector to measure proton flux density;

—Phantom to assist in synoptic mapping of biological hazards of trapped space radiations;

—Proton spectrometer that allows proton energy spectrum measurement to be made in conjunction with data obtained in the Phantom experiment;

—Solar aspect indicator, which provides spacecraft orientation information;

—Low-energy magnetic electron spectrometer to measure electron flux as a function of energy and pitch angle distribution;

Also to be injected with the same launch vehicle is another *Lincoln Experimental Satellite* (*LES*) and a radar calibration sphere. ■

Voyager RFP's Due This Month

Boeing, GE and TRW to do systems definition, preliminary design; development of Mars landing capsule is lagging

NASA WILL ISSUE a request for proposals this month to three firms for systems definition and preliminary design of the *Voyager* spacecraft.

One of the firms will then be selected, in about 10 weeks, for the contract. The same firm is almost certain to be picked for hardware development of the spacecraft system, which will be initiated next year.

The three firms—Boeing Co., General Electric Co. and TRW, Inc.—completed feasibility studies of the *Voyager* spacecraft in August. The program has an estimated cost of $1.3 billion, with its first operational mission scheduled for 1971.

The spacecraft is expected to weigh 2,000 lbs. and have a lifetime of 6-12 months in orbit. It will also have room for 200-300 lbs. of experiments. Its power system will have a capability of 600 watts.

The decision to issue the RFP indicates that the program has now been given the official go-ahead by the space agency. Program offices have now been set up at NASA Headquarters and at Jet Propulsion Laboratory, which will have field center responsibility for *Voyager* development. In-house studies are also being made at Marshall Space Flight Center and Lewis Research Center of the program's *Saturn IB/Centaur* launch vehicle.

- **Capsule development lags**—While spacecraft and launch vehicle systems development are moving ahead, RFP's for feasibility studies of the capsule landing system, which ultimately will land on the Martian surface, are being delayed because of new data on the Martian atmosphere provided by the *Mariner IV* spacecraft. That data now indicates a Martian pressure of 5 to 7 millibars, far below the estimated pressure used as the basis of previous NASA studies of the capsule lander.

Initiation of the feasibility studies had earlier been scheduled for September, but it is now certain that this will not be done until late next month at the earliest. Some NASA officials indicated it might be late in the calendar year before the RFP is distributed. Once the RFP is issued, it is expected that two or three firms will be selected to perform the studies. One of the firms would be named later for a systems definition and preliminary design of the capsule landing system.

The low pressure is forcing NASA to redesign the projected braking system for the capsule as it moves toward the Martian surface. Under study are parachutes as well as retro-propulsion.

- **Test flight in 1969**—Preliminary plans for the *Voyager* program call for the first test flight in 1969 using the *Saturn IB/Centaur* booster. In 1971, the first operational mission will involve an 1,800-lb. spacecraft placed into a Martian orbit ranging from 1,000 to 4,000 km. The landing capsule for this mission could weigh as much as several thousand pounds. By 1975, NASA hopes to fly a capsule past Mars weighing up to 6,000 lbs. ■

Gemini 5 Camera Records Spectacular Views

LEFT: Lower tip of Baja California, Mexico, as seen from Gemini 5 spacecraft. This view, looking south, shows Bahia de la Paz on the left side of peninsula. Photo was taken with a modified 70mm Hasselblad camera. RIGHT: City of Alexandria, Egypt, (lower left) photographed with the same camera from Gemini 5. The Nile River (upper left) and the western desert of Egypt are also sharply defined in the photograph, one of hundreds taken during the eight-day flight.

AF Discloses New Upper Stage

Boeing named contractor for versatile Burner II at AFA gathering; designed for Thor SLV, adaptable to Atlas, Titan

THE MODEL 946 (Burner II) solid upper stage designed to fit the *Thor* Standard Launch Vehicle is being developed by Boeing Co. under a $6.5-million contract from Air Force Space Systems Division.

The contract was announced and the Model 946 was shown at the Air Force Assn.'s Aerospace Development Briefings and related equipment displays in Washington, D.C. last week.

The stage is adaptable to both the *Atlas* and *Titan* booster families, and will be used to orbit unmanned satellites in the payload weight category between the DOD/NASA *Scout* vehicle and the more expensive Air Force *Agena* and *Ablestar* upper stages.

One ground-test model and three flight-test vehicles will be built by Boeing's Aero-Space Div. The stage will have a solid spherical motor developed by Thiokol Chemical Corp.

- **System details**—The inertial reference guidance system will be supplied by Honeywell's Aeronautical Div. The shroud will be developed by Goodyear Aerospace Corp.

The Boeing-designed stage uses a new structural concept in which the primary stage structure functions only as a load path between the payload and the booster.

All aerodynamic loads will be carried by the jettisonable shroud. Attitude control will be by cold nitrogen jets—six N_2 units to handle lesser control, retro-thrust and roll functions, while four hydrogen peroxide units will take care of the larger control functions. All units will be supplied by Walter Kidde & Co.

The Honeywell guidance package will have a programmer/intervalometer, velocity meter, inverter, flight-control electronics and a three-axis gyro reference unit. The programmer/intervalometer and inverter were developed for the *Scout* program.

The programmer provides 10 separate torqueing levels—each adjustable to within 0.4% of any value within its range. The intervalometer has 28 timed, single-pole, double-throw switch closures that can be set for any time delay between zero and 2621.43 seconds in 0.01 sec. increments.

- **Vehicle's accuracy**—The expected accuracy of the system in placing a payload into a low Earth orbit is ± 50 n. mi. with respect to the apogee/perigee difference. The altitude difference is expected to be ± 20 n. mi. and the inclination error is expected to be limited to ± 0.2°.

The TE-364-2 Thiokol motor is a 37-in.-dia. spherical unit with a submerged nozzle. Nozzle expansion ratio is 53:1.

The basic structure of the Burner II is a conical shell riveted to three equispacial vertical beams. The payload is attached to the forward end of the vertical beams and the outboard chords of the beams are attached to the booster interface at three equally spaced points.

The stage is designed so that all critical components are easily accessible. The payload will be installed after checkout of the Model 946. Hold time launch capability of the stage is extremely flexible—up to the last 2.5 minutes of the countdown, at which time electrical power is activated.

The stage is expected to be operational in late 1966 and the development program is scheduled to last only 18 months. The Boeing cost breakdown pegs the stage at $246,000 and its shroud at $8,000. The airborne data telemetry system costs $32,370; associated ground support equipment, $150,000.

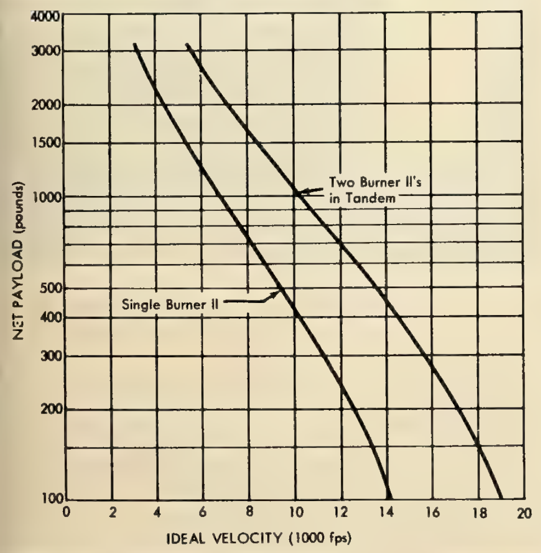
Boeing plans include a modified Burner II assembly that can be used in tandem with the fully equipped stage to increase velocity and payload.

- **Scope of show**—Some 39 firms conducted 42 separate briefings on their respective products, programs and technologies at the conference. Ten other firms presented displays only.

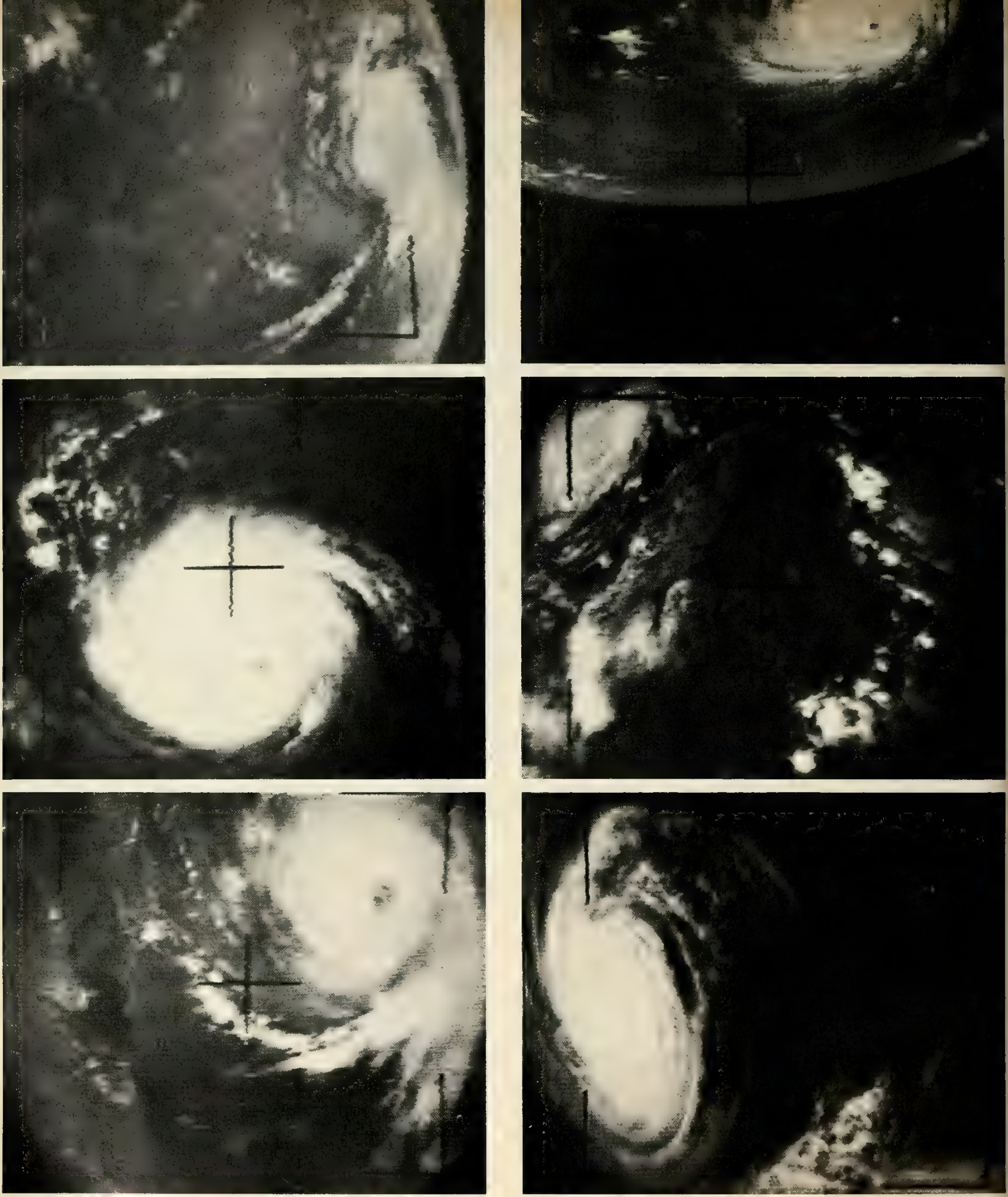
During one session Texaco Experiments, Inc., officials disclosed that the firm is studying materials other than boron for filaments having exceptionally high strength and stiffness.

These materials, "of interest to the Air Force," according to the company, include graphite, beryllium, silicon carbide, boron carbide and titanium diboride. Texaco hopes to be able to draw filaments of these materials, embed them in a suitable matrix and extrude structural shapes.

Texaco also revealed details of a boron monofilament pilot production process. The 0.5-mil substrate material is first heated electrically as it passes down a small-diameter production tube. Gaseous boron compounds admitted to the tube dissociate on contact with the hot substrate, depositing elemental boron. The spent gas exits near the end of the 20-ft. tube. The fibers are bonded into a matrix and subsequently gathered into production lots. ■



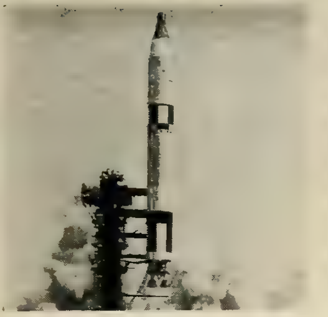
IDEAL velocity curves for basic Burner II configuration and tandem concept developed by Boeing are shown. Stage can provide attitude stability and precise increments of velocity to payloads for orbital injection, Earth escape and re-entry.

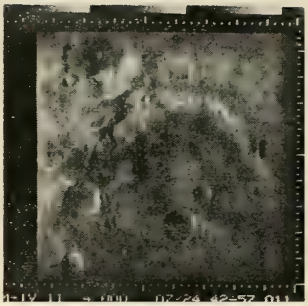


Hurricane Betsy Viewed by TIROS Satellites

FROM ITS EARLIEST beginnings until its fury was expended, the progress of Hurricane Betsy was observed each day by three *TIROS* satellites, numbers —*8*, *9* and *10*—which transmitted photographs of the storm.

UPPER LEFT: On Aug. 30, the storm gathered strength out over the Atlantic, about 250 miles north of San Juan. It was photographed by *TIROS 9*. UPPER RIGHT: By Sept. 2, the eye of the storm is clearly visible in a *TIROS 8* picture. MIDDLE LEFT: The storm was moving slightly northwest, the force of its winds clearly visible in a straight-down view from *TIROS 10* on Sept. 3. MIDDLE RIGHT: On Sept. 5, the hurricane menaced Florida. The peninsula is shown with the camera looking southeast, with the storm in the upper left in the distance. LOWER LEFT: Betsy turned southward, threatening to engulf the entire island of Cuba on Sept. 6. LOWER RIGHT: The storm turned again and hit Louisiana as photographed by *TIROS 10* on Sept. 10.





what's next nasa?

MISSILES AND ROCKETS asked this probing question "What's Next NASA?" And on November 29, 1965, MISSILES AND ROCKETS will publish its Fifth Annual NASA Issue with answers to this question as well as an authoritative examination of the National Aeronautics and Space Administration's current and future projects and facilities.

After a year of spectacular achievement, including Astronaut White's record extravehicular space walk and Gemini 5's record 191 hours in space, NASA is looking ahead to its new space programs. Special emphasis is placed in this issue on the Apollo Extension Systems (AES) which have an estimated total cost of over $1 billion, and project Voyager, which will explore Mars, Venus and other planets.

This special issue will also explore NASA's plans for other new projects as the U.S. space program begins its swing away from the exploration of the Moon to the vaster and more challenging mission of probing the planets.

MISSILES AND ROCKETS provides the recognized and authoritative route to reach the men who will be making the research, design, engineering and procurement decisions in these new multibillion-dollar programs.

BONUS CIRCULATION: By request, the fifth annual NASA issue of MISSILES AND ROCKETS will provide 5,000 bonus circulation to the decision-makers in Government, the Atomic Energy Commission and the National Aeronautics and Space Administration.

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missiles and rockets
THE WEEKLY OF ADVANCED TECHNOLOGY

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Technical Countdown

MATERIALS

Pure Fiber Boron Nitride Available

Limited quantities of a pure fiber form of boron nitride can be purchased from the Carborundum Co. for laboratory activities in pound lots at $175 and four-ounce samples at $75. Officials of the firm say there are no major technological problems anticipated in scaling up to commercial levels. The boron nitride fiber provides the properties of the compound in composite applications. The fiber can take temperatures up to 4,500° F in an inert atmosphere and is immune to attack by most organic solvents and corrosive agents. Oxidizing atmosphere function is limited to 1,700°F. Chlorine has little effect up to 1,300° F. Fiber purity is greater than 99% boron nitride. Its dielectric properties open a potential market area in electrical insulation. The fiber texture and the characteristics of boron nitride offer a possible use for protective clothing and other radiation and chemical shielding. The fibers are not continuous filaments and have a tensile strength higher than 200,000 psi. Its modulus of elasticity is 13 million psi and the strength-to-density ratio is defined as good by Carborundum officials.

Welding Wire Meets HY140 Steel Specs

A new welding wire alloy, AX-140, economically produces excellent weldments in ductile steel plate having a yield strength of 140,000 psi. The 140,000-psi plate was developed by U.S. Steel Corp. under Navy funding, and is twice as strong as materials now used in submarines. The welding wire alloy was developed by Air Reduction Co. as part of the program and is designed to be applicable to two Airco-patented processes—metal-inert-gas and dip-transfer (interrupted arc). The wire and the steel plate are compatible and meet Navy BuShips standards of not requiring elaborate and expensive procedures.

Aerojet To Sell Base Chemicals

Special compounds manufactured by Aerojet-General Corp.'s solid rocket operations facility for in-house use on various propulsion programs are now commercially available to the chemical industry. The compounds are initially being sold on a development basis. All are aliphatic nitro compounds and include: 1-chloro-1-nitroethane; 1,1-dinitrothane; 2,2-dinitropropanol and 3-nitraza-1,5-pentanediisocyanate. All of the chemicals are made to propellant purities and quality assurance standards. The 1,1-dinitroethane is an enolizable compound with an acid strength approximately equal to acetic acid. The 2,2-dinitropropanol can be converted to unusual esters and acetals. The 3-nitraza-1,5-pentanediisocyanate will undergo all the usual reactions of the isocyanates, but the isocyanate groups are highly reactive and should lead to new varieties of urethanes and ureas.

Battelle To Study Metal Bellows

A two-year, Air Force-funded research program is under way at Battelle Memorial Institute into improving the design, fabrication and performance of metallic bellows and diaphragms. Devices from 0.250 in. to 10 in. in size and operational pressures from 0 to 10,000 psi will be covered by the Battelle researchers. Pressure differentials from 0 to 5,000 psi and temperatures between —423° and 3,000°F will be included. Fluid media to be studied include cryogenic, storable and gaseous propellants. Final results of the program will be incorporated into a handbook to assist manufacturers and potential users. Sponsorship is by the Air Force Rocket Propulsion Lab, Research and Technology Division.

SPACE MEDICINE

Space Diet Causes Changes

Analysis of the intestinal microbial population of subjects on a space-type, freeze-dehydrated diet has indicated some significant changes in the predominating anerobic flora after the subjects had been on the diet for some days, and presence of aerobic flora different than those commonly found. Subjects were from the Air Force's Aerospace Medical Research Laboratories and analysis was done by researchers from Republic Aviation Corp. While effects of changes may be slow, their existence must be recognized, the scientists said.

Convair to Study Artificial Heart

General Dynamics/Convair scientists will study means of organizing the nation's technical, medical, and scientific disciplines to develop an artificial heart on a six-month study contract from the National Heart Institute of the Public Health Service. Goals of the project will be to determine the diagnostic conditions for implanting an artificial heart, to whom the treatment could be applied, and ways of providing a continuous power supply. Another phase of the contract will cover design of an artificial heart pacer that will respond automatically to different body needs.

PROPULSION

UTC Picks Up $1.2 Million in Hybrid Work

United Technology Center will conduct a nine-month investigation of various pre-packaged hybrid propellant systems under a $740,909 contract from the Air Force Rocket Propulsion Lab at Edwards AFB. A second contract totalling $480,980 from the National Aeronautics and Space Administration will extend UTC development work on a throttleable hybrid propulsion system for upper-stage space flight. This system is designed to throttle from 5,000 to 625 lbs. thrust.

Lockheed Tests Two New Motor Concepts

A rocket motor combining the features of a solid propellant and hybrid technology has demonstrated pin-point controllability in thrust variations, stops and restarts at Lockheed Propulsion Co. The unit uses a high-energy solid grain with small, metered amounts of a hypergolic liquid (M/R, March 1, p. 28). The restartable solid variable pulse (RSVP) motor is ignited by injecting chlorine trifluoride into the chamber area in the solid. The metering valve can be command operated to control thrust or can be pre-programmed. Thrust termination is achieved by cutting off the hypergolic liquid. The primary purpose of the liquid is pressurization. It functions with a designed oversize nozzle. LPC also test-fired a flightweight wafer motor—running the dual-thrust unit through a firing program simulating that for an air launched tactical missile. Previous firings of this system have demonstrated its applicability to SRAM propulsion system requirements. The wafer-pulse motor is being funded by the Air Force Rocket Propulsion Lab while some aspects of the RSVP motor involves Air Force conjunctive effort.

Single Silicon Slice Foreseen Yielding Up To 1,000 Circuits

by Rex Pay

San Francisco—Production of arrays of 100 to 1,000 logic circuits within a single slice of silicon will be achieved by the integrated circuit industry over the next 1-5 years. The interconnection technology developed for these circuits will also be used in mass-storage cryoelectric memories.

In making this forecast, Dr. R. L. Petritz, Director of the Semiconductor Research and Development Laboratory at Texas Instruments, Inc., told the AIME Technical Conference on Materials Science and Technology in Integrated Electronics that a number of developments would play a part in making these complex arrays feasible.

In particular, multilayer interconnection schemes making use of organic photoresist layers as insulation are showing great promise as a means of linking up arrays of circuits on a single slice. The same technique is being used by Texas Instruments in the development of a 250,000-bit cryoelectric content-addressable memory. This is scheduled for completion next fall and could be the first demonstration of an operating large-scale cryogenic memory.

Other topics reported on at the conference included microwave strip-line for integrated circuits, a solid-state vidicon made up of 12,800 phototransistors, formation of p-n junctions for gallium arsenide integrated circuits, production of multiple junction structures with planar characteristics by ion implantation, and doubling of dielectrically isolated integrated-circuit speed by a patterned epitaxial process.

This last process has been demonstrated in TI laboratories and involves the application of epitaxy to a selected region of the single-crystal pockets of silicon contained within dielectric isolation. It gives a well-defined surface for diffusion technology and cuts circuit capacitances sufficiently to raise speeds from the 3 nanosec. to the 1.5 nanosec. range.

Because dielectric isolation is an expensive process, the promise of higher performance is significant.

- **Reducing capacitance**—Petritz emphasized that integrated circuit capacitance had to be cut if the nanosecond barrier was to be broken. He said the patterned epitaxial technique formed a good next step over purely mechanical processes and looked very feasible on a laboratory scale. Other approaches are the beam lead technique and the sapphire substrate.

The production of interconnected arrays of logic on a single slice will put the onus for speed reduction on the integrated circuit designer, because one advantage gained is removal of the heavy capacitive load associated with transmission lines connecting discrete circuits. These limit speeds to the 1-3 nanosecond range. When the connection is made on the slice, the transmission time is cut to picoseconds. As a result, said Petritz, greater emphasis is being given to development of non-saturated logic.

J. Cash, Jr., of Texas Instruments described the development of microstrip transmission lines for use in integrated circuits operating above 1,000 mc. These would be used not only for interconnects between devices on a slice, but also for input-output connections and for formation of resonant structures and passive circuit elements. The lines are formed by depositing 0.1 to 5.0-mil-thick metal and dielectric films. Measurements at 9 gc on strip-lines with deposited quartz dielectric showed silver to give the least loss, with gold and aluminum second and third. For a 50-ohm line the line width and quartz thickness are approximately equal, according to TI.

Interconnection of a large number of logic circuits on a single slice requires at least three layers of interconnection and preferably more, said Petritz. In effect, the connection scheme of the currently used multilayer printed circuit boards will have to be transferred to the silicon slice. One result of this development, said Petritz, will be to raise the value of the slice to such an exent that its packaging costs will be comparatively low, so that high-cost, high-performance packages will be preferred.

- **Organic films promising**—He said that in TI work, thin organic insulating films have shown greater promise than oxide films for multilayer interconnects, notably in absence of pin-holes. B. G. Carbajal of TI said that the glow-discharge technique has been used to produce styrene films of 5-18,000 Angstroms thickness with resistivities greater than 10^{16} ohm-cm.

However, photoresist films look even more promising. Type C KMER film, prepared in a proprietary manner, showed very good stability at 250°C in nitrogen. The films were also cycled to cryogenic temperatures with no degradation noticeable.

Use of photomask-photoresist methods to fabricate thin-film cryotrons was described by J. P. Pritchard, Jr., of TI. A 120-bit associative processor, complete with its logic and control circuitry has been produced. Nine photo masks were needed to define layers of lead, tin, and four layers of polymer insulation. Total circuit area was 4 sq. in. and some 2,500 active and 12,000 passive crossings had to be insulated. A 2-mil minimum line width was used.

Pritchard said that the seven memory units produced under an Air Force contract from Wright-Patterson AFB were completely continuous and completely short free.

Noting that this work was an extension of integrated-circuit technology, Pritchard commented that, "In cryotron technology there are no diffusions: all you have to do is to lick the multilayer interconnect problem."

The success of the work on the first processors has led to another Air Force contract to build a content-addressable memory made up of 50 units, each with 5,000 storage circuits. One cell has been built and checked out; a set of four cells has now been put together and the word control circuitry is being developed. This will yield two words of two bits each.

The next step will be fabrication of a circuit of 100 words of 50 bits each on a substrate measuring 1.75 in. by 3 in.

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These circuits make use of AZ-17 photoresist, which has a breakdown voltage of 100v per micron and has been cycled between 3°K and 700°K without degradation. The material has the advantage of being completely soluble in acetone. Techniques of protecting the material during processing are proprietary.

Main areas for application of cryoelectric technology are in associative processors and in mass memories of one billion bits.

● **'Brightest star'**—Commenting on developments in cryoelectronics, H. L. Caswell of IBM Watson Research Laboratory described photoresist techniques for insulation as "the brightest star for many a year on the cryoelectric horizon." However, he cautioned that the need in this technology was for between 1,000 and 1,000,000 components on a substrate, depending on the application.

"Also," he said, "there is no question that if cryoelectrics are to become a commercial project, much more work is needed on the cryogenic cooling system." He pointed out that current refrigeration systems would only operate for several hundred hours before needing maintenance.

Another challenging problem raised by low-temperature operation, he said, is the need for superconducting connections between incoming strip lines and memory planes, to minimize heat generation. Also it would be desirable to have individual memory planes demountable. The most promising technique he described for interconnecting memory planes involved edge joining of substrates by epoxy resin and evaporation of interconnections over the joint.

● **Cryogenic computer seen**—Caswell believes a cryogenic computer may be seen in the near future.

Work at TI has shown that 1-micron lines of lead, 0.5 microns thick, can be produced. The current program working with a minimum of 1-mil lines is by no means pressing the limit of the technology.

B. G. Slay of TI reported that studies of the properties of devices fabricated with thinner line widths showed that use of a 0.5-mil control element and a slightly narrower gate than in the present circuits would enable a lower crossing ratio and so give an increase in circuit speed.

Noting the increasing similarity between integrated circuit and cryoelectric production techniques, Petritz pointed out that both provided a way of achieving a truly integrated technology. They both offer to lead to the processing of complete electronic functions. He thinks that the present emphasis of batch processing may be too strong, since it is not fundamental to integrated electronics. Continuous processing might be used in the future, maybe by a ribbon technique, he said.

He also emphasized that monolithic integrated circuits represented a well-established technology that would be hard to displace. Furthermore, many developments were leading to improvements of this technology, he said.

He said he believes that the gold-aluminum technique of bonding was the most reliable system for making connections to an integrated circuit chip. But for high-temperature operation he thinks that use of a bimetal molybdenum-gold system shows great promise. Describing this technique, J. A. Cunningham of TI said that it was a solution to the "purple plague" problem and argued that molybdenum is the only suitable engineering metal for use as the first layer in a metal-gold sandwich contact system.

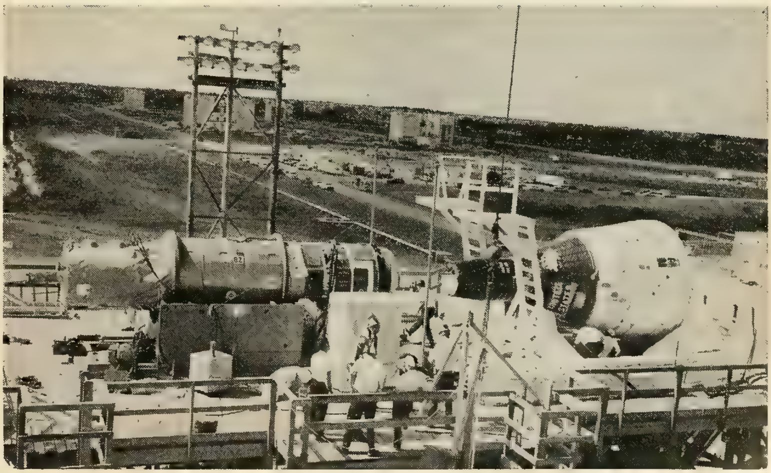
● **Solid-state vidicon**—Following its fabrication of a 2,500-element solid-state image converter, Westinghouse is now turning to development of a 12,800-element array, under a contract from NASA's Marshall Space Flight Center. Describing development of the first array, M. A. Schuster said that the unit was made up of a 50x50 element array of silicon photo-transistors mounted on a printed circuit board that snaps into an image converter system.

Fabrication was by epitaxy and planar diffusion. Uniformity was found to be fairly good, and provided several shades of gray within the image. Spectral sensitivity peaked at 0.7-0.8 microns and the device showed a fairly linear response over a dynamic range of three orders of magnitude. Minimum detectable signal was 10 nanowatts and saturation signal was 0.5 milliwatts.

More advanced approaches under study are use of dielectric isolation to enhance characteristics, particularly electro-optical isolation. Schuster said that ion-implantation was very desirable to get sharper junctions, so that sensitivity could be enhanced at the blue end of the spectrum.

● **Ion implantation**—A capability for making planar type devices by ion implantation was claimed by C. B. Sibley in describing work carried out at National Research Corp. Multiple-junction structures fabricated by this technique have shown sharp planar characteristics, he said. One of the chief advantages of the technique is the speed of production. Problems are encountered due to the presence of extremely small dust particles that cause pipes through the junction. Crystal damage by the ion beam can be annealed out by heating to 600°C for 10 minutes, said Sibley.

● **Gallium arsenide**—Studies at Texas Instruments of techniques for forming gallium arsenide integrated circuits in a matrix of semi-insulating gallium arsenide have shown that p-n junctions can be formed with desirable characteristics. E. W. Mehal of TI said that doping with oxygen or chromium gave satisfactory d-c isolation in gallium arsenide. Capacitive and piezoelectric effects appeared to give no stray coupling problems. Optical coupling due to light emission at p-n junctions could be controlled by the shifting absorption edge, or the optical coupling could be used and controlled as desired. ■



Rehearsal for GTA-6 Rendezvous

GEMINI CAPSULE and Agena vehicle with which it will rendezvous and dock during the GTA-6 flight of Astronauts Walter Schirra and Thomas Stafford are brought together to check docking procedure at Cape Kennedy. The launch is set for Oct. 25.

White Sands ARTRAC Network To Be Operational by Next Summer

WHITE SANDS, N.M.—Work has begun on the instrument data transmission system (IDTS) that ties together the parts of White Sands Advanced Range Testing, Reporting, and Control system—a microwave communications network. The network is scheduled to be operational next July.

The ARTRAC network will be made up of a microwave/multiplex and high-speed data-transmission system supplied by Lenkurt Electric under an initial $1,852,000 contract from Astrodata Inc.

Astrodata recently was awarded a $3,557,721 contract by the Army for the total range requirements for ARTRAC (M/R, Feb. 1, p. 32). This represents the first year's buy. The total contract for specified items amounts to $7.2 million. The final contract is expected to be about double this figure after non-specified items have been negotiated, Vernon Miller, chief of the White Sands Range Instrumentation Systems Office, told MISSILES AND ROCKETS.

A contract for the new range telemetry data center is expected to be announced within a week or two. Specifications of the ARTRAC central computer are expected to be issued by White Sands officials at the beginning of next year.

• **Expanded capability**—ARTRAC represents the system that will take White Sands missile ranges into the 1970s with a capability to handle many more missile firings than the present 3,000 per year and to control, in real time, on and off-range firings.

Lenkurt's five-year contract is funded year by year, says President Robert J. Gressens. He expects that at the end of the period the firm will have provided equipment and services totalling more than $3 million.

Equipment to be provided by Lenkurt includes its 76C microwave radio system, 46A multiplex system, 57B switching equipment, 936 alarm system, 53C order wire equipment and the company's new 26C data transmission equipment, capable of up to 24,000 bits per second.

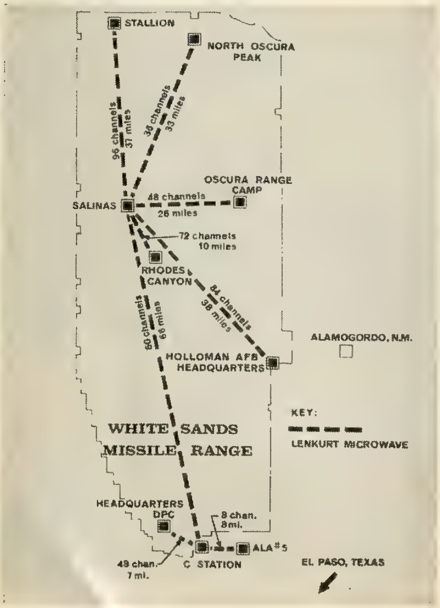
Initially, the IDTS will provide 827 voice channels. When operational at the end of the first year, the system will have a 1,200-channel capacity.

• **Versatility**—The communications network will carry control, command, and instrument data as well as administrative functions, and commercial direct-distance dialing. It will provide direct connections to the Bell System with multi-channel groups for access to off-range facilities, such as the *Athena* launch site in Utah.

On WSMR, the microwave/multiplex system will connect ADCs (Area Data Centers) to the DPC (Data Processing Center) located at the headquarters of the White Sands missile complex. The system is also connected into U.S. Air Force facilities at Holloman AFB, near Alamogordo, N.M.

The ADC's will act as switching centers and data-collection points. Data are transmitted to them from various instrumentation sites such as camera, radar, radio, optical and Doppler tracking facilities.

The microwave/multiplex system, when installed, will be utilized principally for voice communication, but as an increasing number of data terminals is installed, the data transmission load will increase. ■



INSTRUMENTATION Data Transmission system being installed at White Sands Missile Range will link area data centers to the data-processing center being installed at range headquarters as part of ARTRAC system. The ARTRAC network in scheduled to become operational by summer of 1966.

Laser Advances Affect Communications, Radar

SAN FRANCISCO—Important new advances in laser technology, both with gas and optically pumped solid-state devices, may speed their practical application in communications and radar.

Experiments conducted by scientists at Bell Telephone Laboratories, reported on at the Western Electronics Show and Convention (WESCON) held here late last month (M/R, Aug. 30, p. 10; Sept. 6, p. 18), indicate significant gains in power output and efficiency for both carbon dioxide/nitrogen gas lasers and optically pumped neodymium-doped yttrium aluminum garnet (YAG) devices.

The gas laser system, described by C. K. N. Patel of BTL, has recently achieved cw power outputs of 16 watts and efficiencies of 4%, both of which are believed to be the highest ever achieved for gas lasers. The importance of this development to communications results from its ability to operate as a monochromatic source in the 10.6-micron (infrared) band, which is at the center of the atmospheric transmission window extending between 8 and 14 microns. No other monochromatic device is believed to exist in this region.

Patel estimated that theoretical efficiencies of these devices could go to 40%.

- **Two modes**—The BTL experiments using the Nd:YAG laser involve both cw and Q-switched pulsed operation. BTL has already reported cw power output of 1 watt at 1.06 microns in the near-IR for this device using a tungsten lamp for pump power of about 1,000 watts, yielding laser efficiencies of roughly $\frac{1}{10}$%.

J. E. Geusic of BTL told MISSILES AND ROCKETS that efficiencies of 2% should be possible. He also said that more recent tests at BTL have yielded 3-watt cw outputs, and that new effort on improving the pumping scheme could up this to 10-15 watts.

BTL has also been able to Q-switch the tungsten-pumped YAG devices to get 1-kw peak powers in a continuous chain of pulses at a 5-kc repetition rate, Geusic said. The BTL scientist also feels that this is not an upper limit and believes powers to 10 kw are possible using tungsten pumping.

The single-frequency YAG devices are reported to have very good pattern characteristics that might make them useful for cw Doppler radars, or for range-rate radars in the Q-switched mode. The tungsten-pumped cw device is also said to be a relatively compact, water-cooled room temperature unit that would have handling and operational advantages.

Geusic also points out that YAG devices pumped by higher power but less-efficient argon arcs have yielded cw outputs as high as 40 watts, citing work performed by the Linde Corp. Geusic said this technique could probably be expanded to yield 100 watts cw in the near future. He estimated that Q-switched, argon-pumped YAG lasers might yield $\frac{1}{10}$ megawatt.

- **Potential in green**—Geusic also revealed that BTL has achieved a milliwatt of laser output in the green portion of the spectrum by incorporating a lithium niobate crystal in the YAG laser. Outputs of hundreds of milliwatts are anticipated. ■

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GT-7 Will Emphasize Calcium Study

Report says GT-4 and -5 crews underwent changes up to 15% in calcium content, also experienced decrease in red blood cells

by Heather M. David

GEMINI ASTRONAUTS on the *GT-4* and *GT-5* missions experienced bone calcium changes of 8-10% in the 4-day mission, and 12-15% in the 8-day mission, preliminary data on medical experiment M-6 show.

While a more thorough analysis is underway, NASA is increasingly interested in a thorough calcium loss study, scheduled to be performed on *GT-7*, the 14-day mission scheduled for next year. *GT-7* is the only remaining medical mission in the *Gemini* series.

The apparent calcium losses were detected through the bone densitometry experiment, which involved pre- and post-flight X-ray measurements of the oscalcis (heel bone) and the distal phalanx (end bone) of the right fifth finger.

During the 14-day flight, an effort will be made to measure carefully controlled calcium intake and output, pre-flight, in-flight and post-flight. Measurements also will be made of nitrogen, phosphorous, potassium and sodium, magnesium balance, and output of hydroxyproline, the primary amino acid of the bone matrix. The experiment, M-7, will be under the direction of Dr. G. Donald Whedon and Dr. William F. Neuman, respectively directors of the National Institute of Arthritis and Metabolic Diseases, and School of Medicine and Dentistry, University of Rochester.

● **Not health threat**—According to Dr. Charles A. Berry, chief of medical operations for NASA's Manned Spacecraft Center, the findings are interesting data points, but are not considered significant as far as danger to the health of the astronauts is concerned.

The experimental technique used for the *Gemini* flights is new, and NASA doctors are not sure exactly what the changes in density, as they appeared on X-rays, may mean. A question still unresolved is whether the calcium is being lost in the blood or urine.

In the first complete medical report on *GT-4* and *GT-5*, given in a presentation to the National Academy of Sciences, Berry also made these points:

—The long duration *Gemini* missions have conclusively demonstrated man's ability to adapt to the weightless state, and then readapt easily to the one-g environment.

—While some blood composition changes occurred, these were part of the adaption and not dangerous. No abnormalities in function, such as delay in the electrical and mechanical action of the heart as reported by the Soviets, were observed in the flights.

—While the orthostatic hypotension, which was first noted in *Mercury* astronauts Walter Schirra and Gordon Cooper, has occurred to every astronaut following a long-duration mission, the condition as measured in the *Gemini* pilots has been without symptoms, tending to indicate that the phenomenon is not caused exclusively by weightlessness.

—The only complaints from *GT-5* astronauts Leroy Gordon Cooper and Charles Conrad were a slight stiffness from inactivity, and a case of dandruff.

● **Circulatory system**—While the *GT-5* mission demonstrated that a definite adaption takes place during the weightless state—with heart rates leveling off during the latter days of the flight at 10 to 20 beats less than the normal rate—the post mission recovery time was no longer than during the much shorter *Mercury* flights of Schirra and Cooper. This was definite evidence of man's ability to quickly readapt to the normal Earth gravity, a feat previously in doubt among some physicians.

The adaption to a lower heart rate was first noticed at the end of the *GT-4* mission of 4 days, with the leveling off occurring at about the same time during *GT-5* and remaining approximately the same until retrofire.

Blood pressure readings showed that there was no great change throughout the duration of the mission after exercise. The first blood pressures taken during the parachute recovery phase, which in a way resembled a tilt table action as the chute placed the astronauts first in a lying position then in a sitting up position, demonstrated that the condition of orthostatic hypotension was indeed present. Blood pressures were quite low, with increased heart rates.

According to Berry, heart rate seems to be the best indicator of the condition, as the changes are more marked. Two and one-half hours after the flight, the heart rate on the *GT-5* command pilot was about 150, with some improvement after 11 hours. After 30 hours post-flight, the readings on the tilt table were from about 80 to 100. After 47 hours, the blood pressures were back to normal, with heart rates recovering at about 106 hours after the flight.

On the *GT-4* command pilot, pre-flight heart rates ran about 80-90, with this rising to 140 immediately post-flight. At 23 hours, the heart rate was still high. Blood pressure returned to normal at about 32 hours, with heart rate normal at 52 hours.

The fact that the effect was less than in *Mercury* flights, in which astronauts experienced dizziness and pooling of the blood in the legs, may be because of the close attention to water intake, Berry said. There has been considerable scientific dispute over whether the condition was produced in the *Mercury* pilots by weightlessness, stress or dehydration.

The use of blood pressure cuffs in experiment M-1 apparently did not have any major effect on the condition of the copilot of *GT-5*, Berry said. While somewhat quicker return to normal in the cardiovascular system was experienced by Conrad, than by Cooper, who did not wear the cuff, this could have been due to individual differences, Berry said. He also said that he could not make a decision at this time on whether the experiment should be repeated.

Berry said he saw no major changes in the electrocardiogram (EKG) readings during the flight that were not rate-related, and that he was happy with all the readings seen in the 8-day mission.

● **Hematological observations**—A considerable increase in white blood cells was noticed immediately after the *GT-4* flight. In one of the pilots, the count reached 29,050 per milligram immediately after the flight. Some 24 hours later, this had dropped back to a near normal rate of 7,350.

Berry said that there was a definite shift in cells—with an increase in neutrophilia, which some physicians have attributed to the use of the drug ephenephrine.

However, no substantial increase in white blood cells occurred after the 8-day mission, which Berry said may indicate that it is a stress-related response that is time-dependent. Had the measurements been made in space at the 4-day point, he ventured, the higher count might have been present.

Blood volume studies demonstrated that there is a definite decrease in red cell mass during long-duration flights. The post-flight measurements on the *GT-5* pilots, in whom red blood cells were tagged with Chromium-51 radioisotopes, showed that the command pilot had a volume decrease of 13%, a plasma decrease of 8%, and a red cell mass decrease of 20%.

These findings were confirmed by the pilot's measurements, which were identical except for a 4% drop in plasma rather than an 8% drop. Berry said that in addition, a decrease in red cell survival time was noted.

The critical question, the medical chief said, is to determine where the red blood cells are going. The indications are that cells are being destroyed at a faster rate, and that production also may be declining.

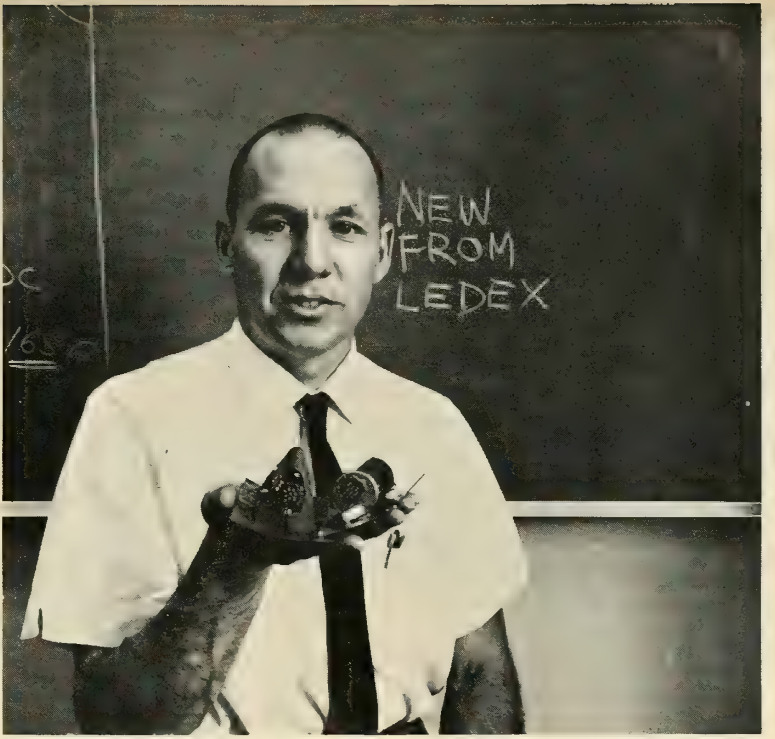
Berry characterized the findings as a normal adaptive process to the weightless state, and not a signal of danger.

- **Vestibular**—No symptoms of vestibular disturbances were noted during either flight.

In comparing his feelings during reentry between the *MA-9* and *GT-5* flights, Cooper said that he definitely was more sensitive to zero-gravity in the longer flight. In the *Mercury* flight, he related, he did not feel the thrust of the retrorockets, and did not notice any g-pull until re-entry. On the *Gemini* flight, he said, there was a definite feeling even before the accelerometer registered any g-force. However, the adjustment was made rapidly, and by the time the re-entry was well underway, he felt "calibrated" to the accelerometer.

Visual experiences during *GT-5* and *MA-9* were about the same, Cooper said, and many of the same areas and features were noted. "The only difference was that this time I had confirmation," he added, referring to the fact that his initial reports of seeing chimneys and roads from orbital altitude were disputed by some scientists as being beyond the power of resolution of the human eye.

Cooper told of experiences on *GT-5* of seeing ships' wakes from a distance of 500-600 miles. ■



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S-Band 'Shakedown' Slated at Guam

First valid workout for tracking, communications ground station to be held during Apollo re-entry exercise next year

by Charles D. LaFond

DALLAS—The first real exercise of NASA's unified S-band tracking/communications station equipment will occur during the second *Apollo* re-entry vehicle test mission scheduled for the first quarter of next year using the new Guam ground station. Now nearing completion, nearly one month ahead of schedule, the Guam tracking station will be put through aircraft-to-ground testing in December and will be operational early next year.

The first of some 13 unified S-band stations is being built for NASA's Goddard Space Flight Center by Collins Radio Co. here under a $25-million-plus contract awarded last year. The total global system is due to be operational in the first quarter of 1967, Collins officials say.

The new unified S-band system (M/R, July 20, 1964, p. 20; Aug. 3, 1964, p. 36), a marked departure from equipment used previously on other manned programs, is expected to greatly simplify and improve both communications and tracking. With the new PCM system, a single carrier frequency operated in the two-gigacycle band will provide for tracking, data transmission, voice communications and video in a two-way link between the ground and the *Apollo* Command Module and Lunar Excursion Module in near-Earth orbit and to cislunar distances.

- **Scope of system**—Under present plans there will be 12 S-band stations employing 30-ft.-dia. Cassegrain dishes located at Ascension Island; Antigua Island; Bermuda; Grand Bahama; Goddard Space Flight Center; the Canary Islands; Cape Kennedy; a location in Texas not yet announced; Guaymas, Mexico; Hawaii; Guam; and Carnarvon, Australia.

The three primary 85-ft. dishes for Goddard will be located at Goldstone, Calif.; Madrid, Spain; and Canberra, Australia. Back-up stations will be located at the JPL Deep Space Instrumentation Facility (DSIF), located at Goldstone; Johannesburg, South Africa; and at Canberra, Australia.

Equipment for the Antigua Island site will be obtained from the dual station at the Collins facility near Dallas. Plans for the use of Antigua at this time, however, are still in doubt because of problems in negotiations with the British for a long-term lease.

In addition to the 30-ft. and 85-ft. stations, the total *Apollo* system will include five S-band tracking vessels located about the globe. These vessels are being modified and equipped now by General Dynamics, Quincy, Mass., and by Ling-Temco-Vought, New Orleans, La. Electronics for them will be supplied by Collins Radio.

The antenna responsibility is held by Collins Radio only for the ground stations. These are being supplied to Collins by Blaw-Knox Co.

Action is expected soon by the Air Force to select a contractor to provide

LEFT: the 30-ft.-dia. unified S-band antenna uses Cassegrain folded optics and sophisticated X-Y mount. RIGHT: Interior equipment includes timing system (center). Behind the timing system at right from front to rear is ranging equipment, which provides PRN code, tracking receivers and exciters, and RF control equipment.

unified S-band equipment for up to eight modified C-135 range aircraft. Douglas Aircraft Co. and Collins are the final competitors in this contest and a decision is expected in the next few weeks.

- **System description**—Dr. George Mansur, director of the Space Systems Div. of Collins and program manager for the unified S-band system, unveiled the first complete dual S-band system at the Collins Dallas facility last week.

In the global net, Mansur pointed out, the 30-ft. stations, employing 10-kw transmitters, will be used for communications to the *Apollo* Command Module during Earth orbit. Some stations will carry dual equipment to permit communications and tracking simultaneously with both the Command and Lunar Excursion Modules.

All the 85-ft. facilities employing 20-kw transmitter power will have the dual communications capability, and the latter will be used when the vehicles are at cislunar distances and during the period the LEM is located on the Moon or during its rendezvous with the Command Module for the return trip.

The 85-ft. facilities will employ two parallel transmitters to provide the 20-kw transmitter output. Beam width of the 35-ft. X-Y mount antenna systems will be slightly more than one degree. The 85-ft. dish beam width will be slightly more than 0.35 degree.

The up-link frequency will be approximately 2,100 mc; the down-link communications will be at roughly 2,300 mc. Data received by ground stations during missions will be employed to update all information and/or will be transmitted to the Goddard Space Flight Center and the Manned Spacecraft Center in Houston.

- **Antenna subsystem**—The 30-ft. Cassegrain feed antenna systems are being supplied by Collins under their contract. The 85-ft. dishes will be Government-furnished equipment. The latter will be solid-surface paraboloidal reflectors also mounted on an X-Y axis configuration.

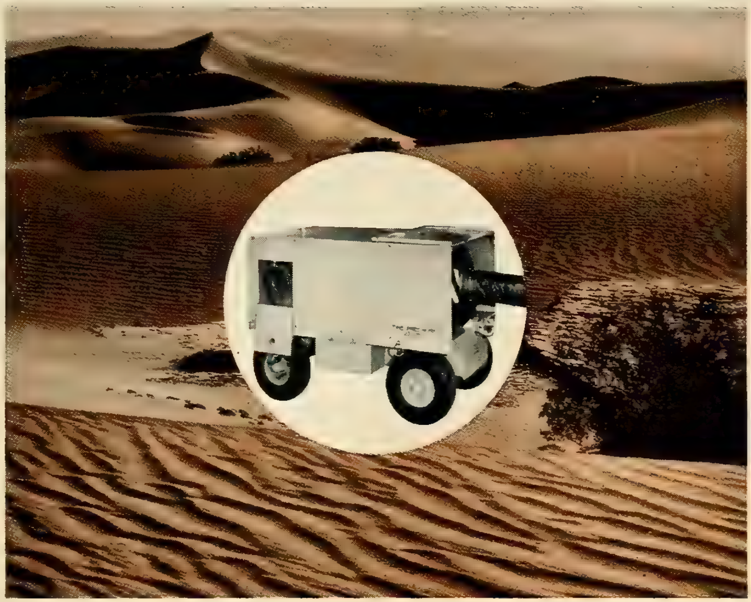
Except in the north and south line, the X-Y mount permits continuous track from the horizon through approximately 180 degrees to the horizon on the other side without experiencing antena lock or a requirement for turnaround at the zenith.

The keyhole, according to Collins, is a structural limit of about 10 degrees elevation and 20 degrees width symmetrical about the north-south line. This limitation is not expected to interfere at any time with the *Apollo* tracking mission because of the position of the *Apollo* spacecraft in both its orbital path and during its cislunar trip.

The Y-wheelhouse of the antenna, located immediately under the dish and rotating on the upper axis (or Y-axis), contains all the equipment to support the antenna. Environmentally controlled, it is air conditioned to maintain a temperature of 75°F, ± 5°, and a relative humidity of 60%. Included in the wheelhouse are the parametric amplifiers for the receiving system. Specially designed racks are provided to facilitate later installations of range and range-rate equipment.

The 10-kw transmitter equipment is housed in the lower shelter located near the ground level. The 30-ft. antenna system, considering the 43-db gain of the antenna, has an effective radiating power of 20 mw. Tracking accuracy of the system, according to Dr. Mansur, is 0.025 degree maximum error. Tracking resolution is 3.6 arc sec. Receiver sensitivity with this antenna and the specially designed receiving equipment is 10^{-18} w, Mansur said.

The programmed or automatic-operation tracking velocity is approximately 2 degrees/sec. The dish, however, can be operated at velocities ranging from 0.0005 to 4 degrees/sec., depending on need and wind-loading conditions. ■



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Expert Sees Future of Titanium As Promising but Demanding

by John F. Judge

FUTURE MAJOR PRODUCTION of titanium will require a more efficient base metal process, and mill products will have to be made on equipment designed specifically for titanium to realize the full economic and quality potential.

Ward W. Minkler, manager of technical services at Titanium Metals Corp. of America opened a titanium metallurgy course at New York University with this realistic appraisal of the metal's future in the aerospace market area.

Unlike other structural materials, titanium production depends on a highly sophisticated customer that has ever increasing demands for engineering preciseness. The metal and its alloys do not have a basic architectural, milk-can, automotive-trim, pots-and-pans type of application buffer zone.

Minkler says the greatest potential for titanium short-time growth in consumption is for airframe structures. If present trends continue, the quantity of titanium used will be a function of the speed of the aircraft and the strength of available alloys.

Except for the Lockheed A-11, the B-70 forward fuselage and some load-bearing structure in the F-4 aft-fuselage, the bulk of titanium airframe usage to date has been for firewalls, heat shields and the like.

Minkler says the transition to greater use in primary structures will demand new product quality standards, shapes and alloys, together with new design considerations and fabrication techniques.

Jet aircraft are expected to create the major demands both in quantity and technology from titanium in the next few years. Minkler says jet engine manufacturers have consumed a major portion of titanium production for compressor sections, blades, wheels, spacer rings and shroud assemblies.

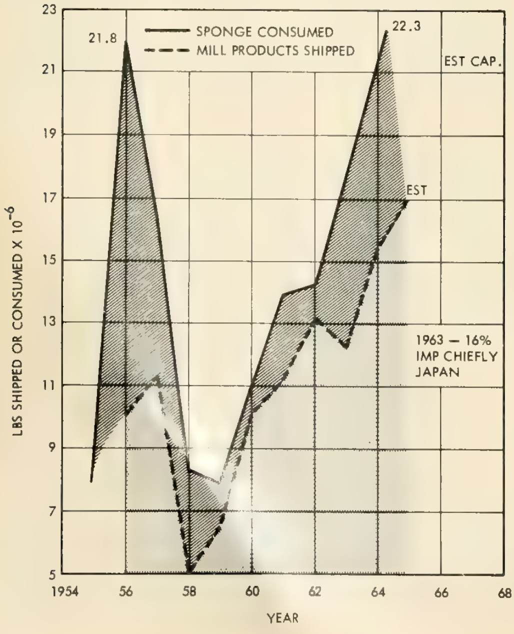
He pointed out that titanium producers expected to lose this market after 1965 because of higher engine operating temperatures—but with the exception of a few-experimental engines, the use of titanium in jet engines is a foundation stone of the current titanium market. It is expected to continue for a few years in this manner.

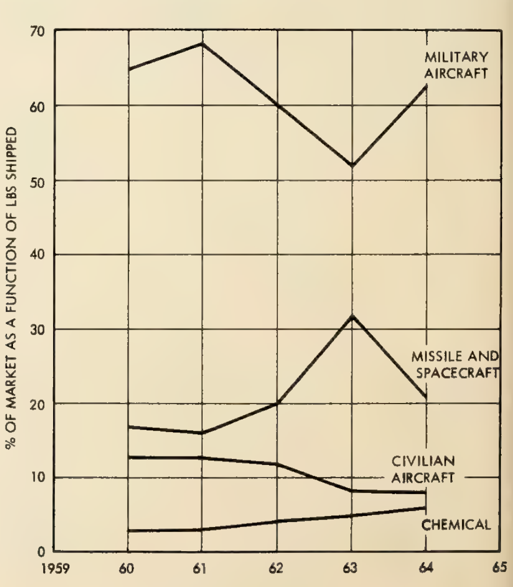
Minkler says this is fortunate because titanium high-temperature alloy development in the 900°F or above regime has been disappointing.

The missile/spacecraft and military market picture for titanium is at a much higher level than civilian aircraft and chemical industry applications.

The missile and spacecraft segment should remain about the same based on the *Minuteman*, *Gemini* and *MOL* projections. It appears, says Minkler,

LEFT: Annual titanium sponge consumption and mill products shipments. RIGHT: Titanium mill product shipments as a function of end-use shows heavy missile/space, aircraft market dependence. No substantial increase is expected in two lower lines.





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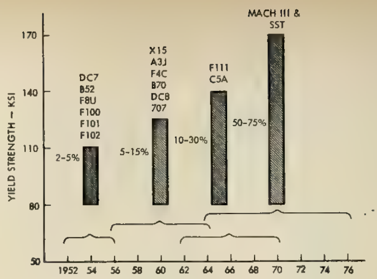

USE OF titanium in various airframes as function of period and strength levels employed.

that titanium has won, at least for the time being, the battle for the Mach 2.2-3.5 airframe—even though structural applications pose a fight.

● **Subsonic market hazy**—Higher strength titanium alloys are fundamental if the metal is to successfully compete in the subsonic aircraft area. "Despite extensive effort, at least in terms of expenditures close to $100 million," says Minkler, "the titanium industry is based upon three compositions, commercially pure titanium, Ti-6Al-4V and Ti-5Al-2.5Sn."

While quality improvements have been made in the last 4 years, the strength level has changed very little. Minkler feels that current alloy heat-treated strengths in the 155,000-psi yield area are not the end of the road, but that further work on composition alone, without concurrent, more precise and better understanding of the physical and mechanical metallurgy of titanium, will be unrewarding.

Minkler's analysis of titanium in 1965 was based on comparison with projections made by Government and the titanium people during the early 1950's—when titanium enjoyed a heavy Government financial involvement.

As Minkler said, one of the favorite pastimes of those involved in the early titanium period was forecasting the vast quantities of the metal required for the immediate future. Some projections reached the area between 200,000 and 800,000 tons annually. In fact, titanium sponge consumed never exceeded 23 million lbs. annually—and only near this level in 1956 and again last year.

Minkler says the industry has grown at an average rate of 25% since the drastic reduction of Government support in the latter part of 1957—and if the pattern of the last 5 years continues, expansion of both basic titanium sponge production capacity and melting, rolling and forging facilities will be necessary.

● **Aerospace quality factor**—The cost of titanium has always been a major factor affecting its market, and Minkler says this will continue. The titanium industry is no different than any other basic metal producing industry and physical plant in that equipment forms a large part of production costs.

Early tonnage versus price projections underestimated the constant increase in customer quality requirements. Minkler says the ingot melted in 1960 would be unacceptable for most 1965 applications and the quality of the 1965 product may be marginal by 1967.

In 1954, Professor H. Kellogg of Columbia University was chairman of the Government's Titanium Advisory Committee, Office of Defense Mobilization. At that time, Prof. Kellogg developed some projections on titanium sponge and mill stock prices based on a plant producing 77 million lbs. of such products annually. This base is substantially more than the entire titanium industry currently produces.

At the moment, only titanium sponge is down close to the Professor's projection of $1.15 per lb.

Minkler says there are other routes to price reductions—such as a more efficient sponge manufacturing process and mill product production on machinery specifically designed for titanium work. Neither will come easily; the sponge process development will be the tougher of the two.

The current titanium sponge process is the Kroll Process—reaction of titanium oxide with chlorine to form titanium tetrachloride, followed by a reduction of the chloride with magnesium or sodium to form the titanium metal known as sponge.

Minkler says the difference between finished product and sponge cost is disappointingly high with respect to other flat rolled metal products. Working environments, necessity of surface removal and the fact that the bulk of titanium has been rolled on hand sheet mills, contribute to this cost disparity.

Timet has already installed a continuous vacuum anneal line in its Toronto, Ohio, plant. Vacuums of less than a micron are used and the reels are outside the vacuum chamber—leading to a reasonable production ability. Minkler says there will soon be other examples of special equipment, especially in the production of titanium tubing, wire extrusions and larger plates.

Titanium alloys can be effective in direct competition with aluminum and steel for many portions of such vehicles as the large military transport program (C5A), helicopters and VSTOL aircraft. Minkler feels that with strength improvements, the aircraft manufacturer can skillfully utilize certain characteristics such as welding to develop new design concepts. ■

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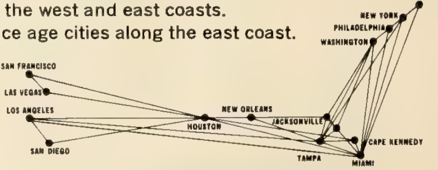

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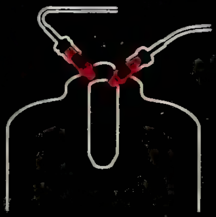

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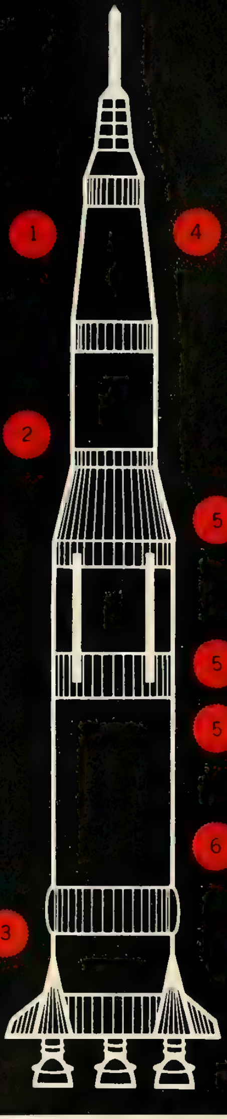

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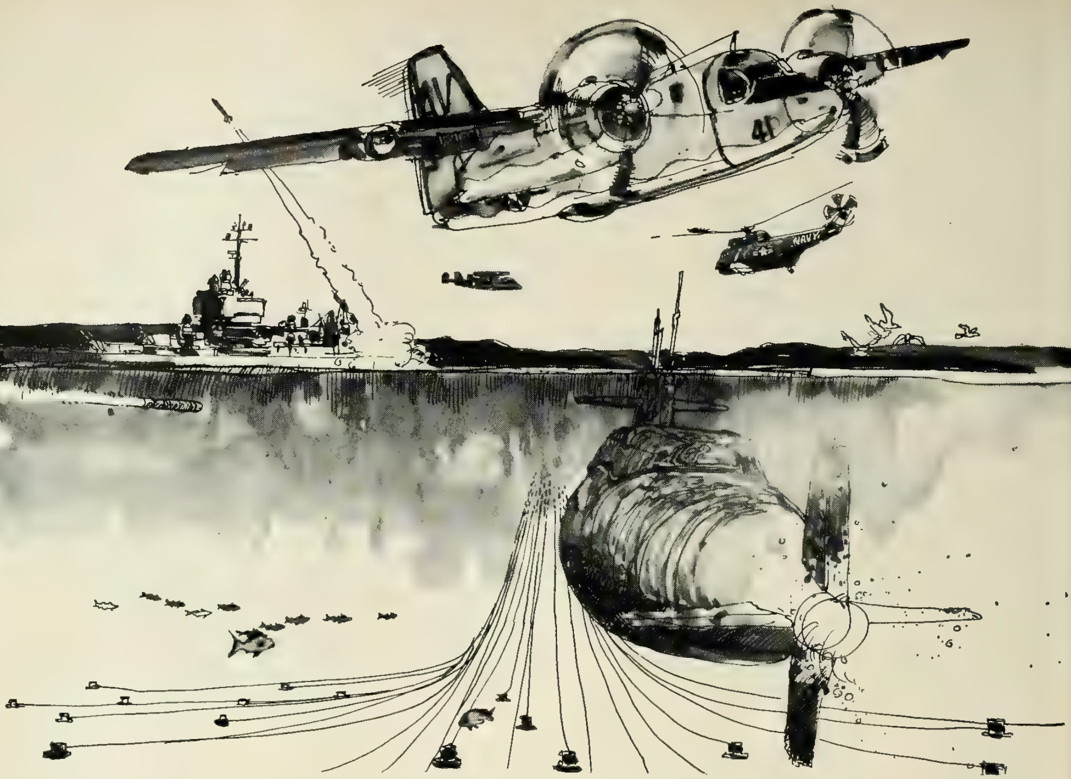

The answers to USW will come from the Tongue of the Ocean.

The Tongue of the Ocean—a large, deep and stable undersea area in the British Bahamas—is the site for AUTEC, the U.S. Navy's new Atlantic Undersea Test and Evaluation Center.

ITT, as prime contractor for AUTEC, is now establishing at the site a unique underwater laboratory measuring some 175 watery square miles. Work has already begun to implement the highly sophisticated electronic systems planned for this vast weapons range facility.

The AUTEC range will be 35 miles long and 5 miles wide, with an impact area 6,000 yards in diameter at its southern end.

AUTEC will permit the whole range of undersea warfare problems—detection, classification, pinpointing and destruction—to be examined in a controlled, yet authentic, environment.

The facility's instrumentation gear, including underwater hydrophone arrays, will enable the Navy to sort out real target information from the rest of its watery environment. This is one of the most complex problems of antisubmarine warfare.

ITT is also prime contractor for Kauai Fleet Tactical Range (KFTR), the Navy's deep-water tracking range off the coast of Kauai Island, Hawaii. This 50-square mile range will provide the Navy's Pacific fleet submarines, surface vessels and aircraft with an instrumented site for conducting tactical exercises.

ITT's broad-range capability for facilities such as AUTEC or KFTR includes equipment for high density storage of multi-channel analog information, recorders for underwater environments, highly sophisticated sonar simulators, signal processing and acoustical hardware, and ocean engineering.

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Mergers and Acquisitions

Computer Sciences Corp., El Sugundo, Calif., has reached agreement to acquire Sichak Associates of Nutley, N.J., designer and producer of communications systems and electronic components for government and industry. Sichak Associates will become a wholly owned subsidiary of CSC upon completion of the acquisition. . . . *Bala Corp., Bala Cynwyd, Pa., diversified holding company, has acquired all outstanding common stock of Consolidated Missile Co., Inc., of Torrance, Calif. The transaction was concluded for cash and notes totaling more than $1,000,000. Consolidated Missile makes components for Titans I and II, Saturn V, and several advanced aircraft.* . . . Brush Beryllium Co. of Cleveland has acquired all outstanding stock of Industrial Enterprise Co., also of Cleveland, which machines metal parts for defense and commercial markets. Included in the deal were two Enterprise subsidiaries, Numerical Machining, Inc., and Enterprise Land, Inc. Price of the acquisition was not disclosed. . . . *Directors of Hurletron, Inc., Chicago, manufacturer of electronic timing and sensing devices, have approved the incorporation of its Control Products Div. in Whittier, Calif., as a wholly owned subsidiary. To be known as Hurletron-Whittier, Inc., it will be headed by Dr. Gabriel M. Giannini.* . . . International Telephone and Telegraph Corp., New York City, has completed the acquisition of all outstanding shares of Press Wireless, Inc., through its subsidiary, ITT World Communications, Inc. . . . *Arlind Co., West Caldwell, N.J., has purchased and developed a 100-acre tract in a remote area of Andover, N.J. The company has built magazine facilities there for the preparation and blending of primary explosives. Also provided for in the tract is production and testing space for detonators and other small explosive components.*

New Activities

The Boeing Co. has formed within its Aerospace Group a product development organization with the aim of improving new business analysis and acquisition processes. The new organization will combine the group's planning and marketing staffs with certain research groups capable of performing complete systems analyses. . . . *Adhesive, Chemical Enterprises, Inc., has been formed through the acquisition of Coast Pro-Seal & Mfg. Co. of Los Angeles and Chicago, makers of sealants, coating, adhesives and gaskets. Coast Pro-Seal's products are used in electronic encapsulating materials for use in aerospace and aircraft applications, as well as in a variety of commercial and industrial work.* . . . VASCO Metals Corp., Latrobe, Pa., has formed an Advanced Metals Group headquartered in Monroe, N.C. The move aligns VASCO's non-steel divisions, Allvac Metals Co., Monroe, and Armetco, Inc., Wooster, Ohio. . . . *Industrial Tectronics, Inc., has transferred headquarters for its Fluid Film Bearing Div. from Hicksville, N.Y., to Compton, Calif. The division has recently been expanded in all phases, including engineering, research and development, production and sales. The firm makes both rolling contact and fluid film bearings.*

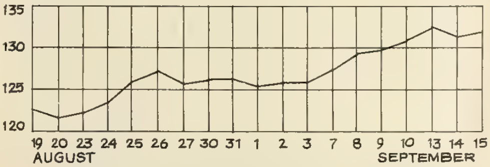
Facility Expansions

The Industrial Gas Div. of Air Products and Chemicals, Inc., Allentown, Pa., has completed and placed into operation the first stage of a $30-million cryogenic and chemical complex at New Orleans. The plant has begun delivery of nitrogen gas at 7,800 psi through a pipeline to the nearby Boeing Co. Saturn Test Facility. The second stage of the facility will go onstream this month and will supply, among various customers, NASA installations throughout the East with 30 tons of liquid hydrogen per day. . . . *Texas Instruments, Inc., Dallas, has begun construction of an 8,000-sq.-ft. semiconductor products manufacturing plant in Sherman, Tex. The Sherman plant will serve the industrial electronics market with transistors, diodes, rectifiers, resistors, and capacitors, and will be the fourth TI semiconductor plant.* . . . Sanders Associates, Inc., Nashua, N.H., has announced plans to begin construction this fall of a major $1.75-million expansion of its multi-plant facilities that will add a total of 150,000 sq. ft. to three plants. The expansion is laid to "rapid growth in a number of new fields, rather that any particular projects."

International

Arthur D. Little, Inc., Cambridge, Mass., has incorporated Arthur D. Little AG with headquarters in Zurich and a branch office in Brussels. . . . *Tele-Signal Corp., Hicksville, N.Y., and Racal Electronics Ltd., Bracknell, Berkshire, England, have entered a long-term license assistance agreement under which Racal is licensed to produce and sell Tele-Signal transistorized communications equipment. Tele-Signal is a subsidiary of General Precision Equipment Corp.* . . . Sanders Associates, Nashua, N.H., has licensed Joseph Lucas Industries Ltd., Birmingham, England, to manufacture and sell its Flexprint line of printed circuits in the British and European automotive markets.

Missile/Space Stock Index



100 = CLOSING PRICES OF 19 REPRESENTATIVE AEROSPACE FIRMS DEC. 31, 1964
STOCK PRICES FURNISHED BY MERRILL LYNCH, PIERCE, FENNER AND SMITH

AIR FORCE

$14,293,400—**System Development Corp.**, Santa Monica, Calif., to upgrade the air defense command and control system.

$4,500,000—**Lockheed Aircraft Corp.**, Lockheed Aircraft Service Co., Los Angeles, for flight-data recording systems.

$4,100,000—**General Dynamics Corp.**, San Diego, for *Atlas-Agena* space boosters.

$3,668,000—**American Electric, Inc.**, Paramount, Calif., for ordnance equipment.

$3,000,000—**General Telephone & Electronics Corp.**, Sylvania Electric Products Inc., Mountain View, Calif., to produce security subsystems for *Minuteman* missile sites.

$2,659,000—**American Air Filter Co.**, St. Louis, to produce an environmental control system for the *Minuteman* missile.

$2,350,000—**Ryan Aeronautical Co.**, San Diego, initial installment on a $6-million contract to produce target drones and related equipment.

$1,463,927—**General Dynamics Corp.**, Stromberg-Carlson Corp., Rochester, N.Y., for communications equipment.

$1,381,133—**Giannini Controls Corp.**, Fairfield, N.J., for continued production of flight data recording equipment.

$784,000—**Space Corp.**, Dallas, for engine test stand.

$740,909—**United Aircraft Corp.**, United Technology Center, Sunnyvale, Calif., for a nine-month investigation of various pre-packaged hybrid propellant systems.

$240,000—**General Telephone & Electronics Corp.**, Sylvania Electric Products Inc., Buffalo, N.Y., for an investigation of the possibility of developing a powerful satellite antenna that would be aimed constantly at Earth.

$129,986—**Block Engineering, Inc.**, Cambridge, Mass., for design and fabrication of missile-borne spectrometers.

$92,800—**Radio Corp. of America,** David Sarnoff Research Center, Princeton, N.J., for exploratory development directed toward achieving intrinsic detectors operable in the 8- to 14-micron region.

$78,850—**Princeton University**, Princeton, N.J., for study of propellant ignition and igniter characteristics.

$69,581—**Systron Donner Corp.**, Concord, Calif., for re-entry analog simulation system.

$50,000—**Midwest Research Institute**, Kansas City, Mo., for high-energy oxidizer stabilization.

$49,500—**Radio Corp. of America**, David Sarnoff Research Center, Princeton, N.J., for solid-state plasma microwave generators.

$39,168—**General Dynamics Corp.**, General Atomic Div., San Diego, for use of seismic techniques in locating underground cavities.

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$27,700—**Atlantic Research Corp.**, Alexandria, Va., for development, preparation and delivery of an uncured solid propellant having a flame temperature of 6,500°F.

$26,576—**Sea Space Systems**, Torrance, Calif., for design, development and fabrication of an aerodynamic buoyant tethered vehicle.

$26,575—**Spectra Physics, Inc.**, Mountain View, Calif., for lasers.

ARMY

$7,753,452—**Radio Corp. of America**, Burlington, Mass., to design and produce test equipment for the *Shillelagh, Lance* and *TOW* missiles.

$6,564,000—**Philco Corp.**, Philadelphia, letter contract for engineering and personnel services connected with an overseas integrated communications system.

$5,760,000—**Page Communications Engineers**, Washington, D.C., letter contract for work on an overseas integrated communications system.

$1,600,000—**Raytheon Co.**, Andover, Mass., for technical requirements, self-propelled *Hawk;* modification to *Hawk* missile system.

$791,068—**FMC Corp.**, San Jose, Calif., for guided missile loader transporter.

$495,249—**General Dynamics Corp.**, Pomona, Calif., for two contracts for additional FY 1966 services and R&D on *Redeye*.

$266,574—**Houdaille-Duval-Wright Co.**, Jacksonville, Fla., to build a 3,000-ft. railway spur into Pad A of Lunar Launch Complex 39, Kennedy Space Center, to serve the propellant storage areas of the pad.

$158,993—**Parkhill-Goodloe Co., Inc.**, Jacksonville, Fla., for *Saturn* barge channel dredging, NASA Merritt Island Launch Area.

$144,589—**Construction Services**, Merritt Island, Fla., for construction of two 20-ft. steel towers atop Pad A for connecting spacecraft support systems piping.

$137,000—**G.C. Dewey Corp.**, New York, N.Y., for prototype L-band radar test set.

$113,832—**Philco Corp.**, Newport Beach, Calif., for change in missile configuration applicable to compact turret (M-60 adoption) to *Shillelagh*.

$88,123—**Thiokol Chemical Corp.**, Redstone Arsenal, Ala., for *Pershing* industrial engineering propellant aging and surveillance test and evaluation program.

$50,000—**Brown Engineering Co.**, Huntsville, Ala., for additional work for laboratory support of *MAW* missile system in areas of engineering, design, development and feasibility demonstration of prototype models and components.

$26,834—**Akwa-Downey Construction Co.**, Milwaukee, Wis., for furnishing and installing air compressors for spacecraft checkout work in the manned spacecraft operations building, cryogenic test building #2, and the life support test building, Kennedy Space Center.

NAVY

$1,942,336—**Sperry Rand Corp.**, Univac Div., St. Paul, Minn., for computer equipment and services.

$1,015,620—**Cameron Iron Works, Inc.**, Houston, to make guided missile boosters.

$939,302—**U.S. Steel Corp.**, Pittsburgh, for guided missile warhead, Mk. 40, Mod O.

$594,000—**General Dynamics Corp.**, Electronics Div., Rochester, N.Y., for production of quantities of AN/ARR-52A radio receiving sets to be used in ASW aircraft to detect and track underwater targets by the reception of signals from sonobuoys.

$330,000—**North American Aviation, Inc.**, Rocketdyne, Div., Canoga Park, Calif., for long-leadtime effort and materials for rocket motors.

$293,775—**Raytheon Co.**, Equipment Div., Wayland, Mass., for research leading to the design and evaluation of a coherent high-power amplitron transmitter.

$250,000—**Condec Corp.**, Consolidated Controls Corp., Bethel, Conn., for the development of a flame-heated thermionic diode to be used as part of a mobile, one-man power plant.

$236,000—**Page Communications Engineers,** Washington, D.C. for instrumentation vans.

$165,489—**Raytheon Co.**, Submarine Signal Div., Lexington, Mass., for design, specification, fabrication, installation, test and checkout of a complete sonar calibration and test facility in the Bahamas for Project Autec.

$153,143—**Hughes Aircraft Co.**, Aerospace Group, Culver City, Calif., for study of missile radar signals.

$120,000—**Dynamics Research Corp.**, Stoneham, Mass., for services, engineering consulting and/or technical, including labor and material for scientific work on the *Polaris* missile ship navigation system.

$117,039—**Vitro Corp. of America,** Vitro Electronics, Los Angeles, for transponders.

$77,892—**Hughes Aircraft Co.**, Culver City, Calif., for research to determine the extent of degradations in optical quality of ruby and neodymium laser rods.

$76,871—**Westinghouse Electric Corp.**, Baltimore, for research study to determine degradations in optical quality of neodymium-glass rods.

$70,755—**Milgo Electronics Corp.**, Miami, for programming missile launcher sequencer.

$35,000—**Ling-Temco-Vought, Inc.**, LTV Aerospace Corp., Dallas, to develop reporting system on logistic support.

NASA

$3,676,100—**Rice University**, Houston, for construction and use of two *Owl* research satellites.

$2,080,000—**Stanford University**, Stanford, Calif., to assist in a Space Engineering Building as part of the science quadrangle.

$1,074,000—**Lockheed Aircraft Corp.**, Missiles & Space Co., Sunnyvale, Calif., for *ISIS-X* mission.

$1,000,000—**Aerojet-General Corp.**, Azusa, Calif., for the *SNAP-8* program.

$480,980—**United Aircraft Corp.,** United Technology Center, Sunnyvale, Calif., for development efforts on a throttleable hybrid propulsion system for upper-stage space flight.

$472,540—**Hughes Aircraft Co.,** Culver City, Calif., for flexible automatic circuit tester, automatic panel checkout equipment.

$152,837—**Space Corp.,** Dallas, to fabricate servicing, handling and installation equipment for Launch Complex 39, Merritt Island Launch Area.

$148,995—**The Bendix Corp.,** Ann Arbor, Mich., for a six-month study on scientific missions to be carried out by astronauts on the *Apollo Extension Systems*.

$64,450—**Airborne Instrument Laboratory,** Long Island, N.Y., for parametric amplifier systems.

$50,000—**Space General Corp.,** El Monte, Calif., to study the application of advanced solid and hybrid motors to sounding rockets.

$49,964—**Stanford Research Institute,** Menlo Park, Calif., for research on adaptive control system design.

$49,955—**General Precision, Inc.,** Librascope Group, Glendale, Calif., for study of failure and reliability in microelectronic devices.

$48,600—**Philco Corp., Aeronutronic Div.,** Newport Beach, Calif., for prediction of nozzle insulation performance.

$46,985—**Hyperion Industries,** Watertown, Mass., for program time receivers and time of day serial-to-parallel converters.

38,920—**Mohawk Wire and Cable Corp.,** Leominster, Mass., for radio frequency cable.

36,138—**General Dynamics Corp.,** Convair Div., San Diego, for *Centaur* mockup for *Saturn IB/Centaur* projects.

28,653—**Bell Aerosystems Co.,** Buffalo, N.Y., for energy management simulation program.

14,364—**Atlantic Research Corp.,** Duarte, Calif., for architect-engineer services for modification to launch areas two and four.

INDUSTRY

3,000,000—**Radiation, Inc.,** Melbourne, Fla., fom **General Telephone & Electronics Corp.,** Sylvania Electric Products Inc., New York City, to make a radar tracking antenna subsystem as part of the current research program aimed at determining whether to go ahead with the *Nike-X* anti-missile program.

1,570,440—**Chicago Bridge & Iron Co.,** Atlanta, Ga., from **Catalytic Construction Co.,** Philadelphia, for the design, fabrication and testing of one 850,000-gal. liquid hydrogen sphere and one 900,000-gal. liquid oxygen sphere to be used in support of the *Apollo/Saturn V* launch vehicle.

1,400,000—**Electronic Specialty Corp.,** Electronic Div., Portland, Ore., from **Magnavox Co.,** Ft. Wayne, Ind., for subminiature relays.

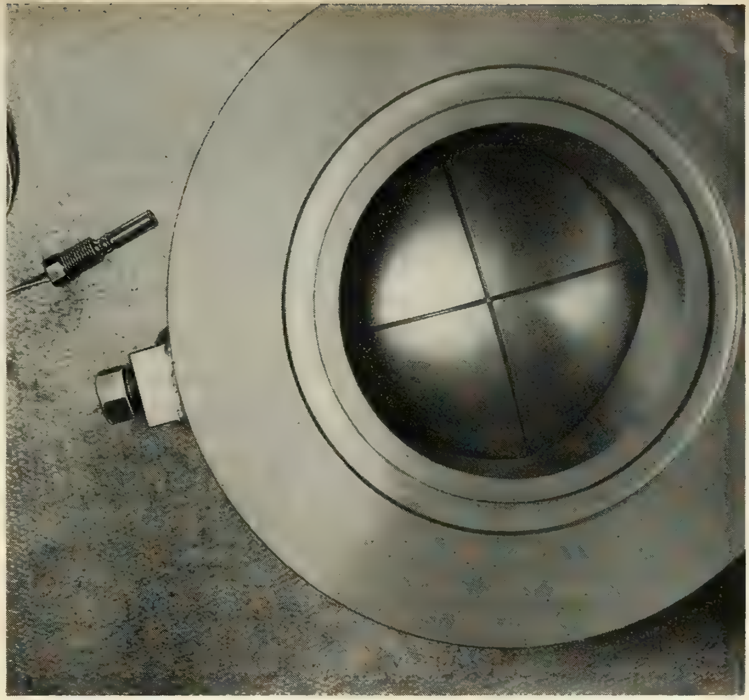
1,124,820—**U.S. Steel Corp.,** Pittsburgh, from **Catalytic Construction Co.,** Philadelphia, for the design, fabrication and testing of sixty-four 6,000-psig gaseous storage vessels to be used in support of the *Apollo/Saturn V* launch vehicle at Complex 39B, Kennedy Space Center.

,000,000—**Fischbach and Moore, Inc.,** F&M Systems Co., Dallas, from **Ling-Temco-Vought, Inc.,** LTV Aerospace Corp., Dallas, for design, fabrication and testing of the complete telemetry systems for two *Apollo* range instrumentation ships.

50,000—**American Electronics, Inc.,** Fullerton, Calif., from **The Boeing Co.,** Seattle, to supply battery charge/power supplies for the *Minuteman II*.

4,000—**Guillemin Networks, Inc.,** Boston, from **Massachusetts Institute of Technology,** Lincoln Laboratory, Boston, for low-pass, 5-cps active filters for use in the experimental large-aperture seismic array project.

eneral Dynamics Corp., Convair Div., San Diego, from **U.S. Department of Health, Education and Welfare,** Washington, D.C., to investigate how the nation's technical, medical and scientific disciplines could be organized to develop an artificial heart (amount not disclosed).



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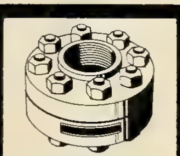

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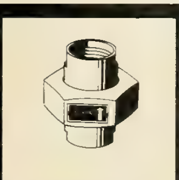

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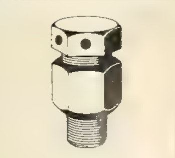

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names in the news

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ORTEGAS

E. W. Foote: Named executive vice president of Canoga Electronics Corp., a new position in the firm. He was also appointed division director of the Canoga Division.

Paul M. Murphy: Appointed manager of the *Minuteman* Project Office at the central operation of Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc. He is responsible for *Minuteman* R&D activities.

Dennis M. Fennelly: Named marketing manager for Radio Corp. of America's Aerospace Systems Div. He will have overall responsibility for contract administration, planning and sales for the division.

Alvin J. Ortegas: Appointed manager of the Hallicrafters Co. Aerospace Div. Washington, D.C., office. He is responsible for the division's liaison with all federal government agencies as well as internal office administration.

Joseph C. Snodgrass: Named executive secretary for the air breathing and rocket propulsion committees of the Aerospace Technical Council, Aerospace Industries Assn. He was formerly commanding officer of the Naval Air Turbine Test Station.

B. J. Hansen: Received the literary award of the Armed Forces Management Assn. for his book "Practical Pert," published by America House, a subsidiary of American Aviation Publications. He is vice president of the John I. Thompson Co., consulting engineers, in Washington, D.C.

Eugene M. Keys: Appointed executive vice president of Oak Manufacturing Co., a division of Oak Electro/Netics Corp. Also appointed was **Paul W. Wheaton** as vice president of marketing.

Robert D. Holland: Elected president of C-E-I-R, Inc. He was formerly executive vice president of the computer and scientific management services company.

Dr. George W. Sutton: Joined Avco-Everett Research Laboratory as a principal research engineer. He was formerly scientific advisor, directorate of requirements and development planning, deputy chief of staff-research and development, Department of the Air Force.

Albert P. Roeper: Elected treasurer of Thiokol Chemical Corp. He was formerly executive assistant to the treasurer.

Harry A. Ferullo: Appointed project manager of the post-boost propulsion system for *Minuteman II* at Textron's Bell Aerosystems Co. He will direct all engineer ing, manufacturing and test activities connected with the development of the small liquid rocket motors, associated positive expulsion propellant tankage and pressurization equipment for the *Minuteman II* system.

Daniel A. Peterson: Appointed development manager of communications equipment at the central operation of Sylvania Electronics Systems, a division of Sylvania Electric Products Inc.

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SEPTEMBER

Fifth Annual National Conference on Environmental Effects on Aircraft and Propulsion Systems, sponsored by U.S. Naval Air Turbine Test Station, Nassau Inn, Princeton, N.J., Sept. 20-22.

Systems Engineering Exposition and Conference, McCormick Place, Chicago, Sept. 20-23.

International Conference on Thermionic Electrical Power Generation, sponsored by Institution of Electrical Engineers, London, England, Sept. 20-24.

Advanced Incentive Contracting, sponsored by National Defense Education Institute (NDEI), Los Angeles, Sept. 21-23.

Third Symposium on the Plasma Sheath-Plasma Electromagnetics of Hypersonic Flight, sponsored by Air Force Cambridge Research Laboratories (AFCRL), New England Life Hall, Boston, Sept. 21-22, unclassified; Base Theater, Laurence G. Hanscom Field, Bedford, Mass. Sept. 23, classified.

Fifth Annual Bio-Environmental Engineering Symposium, sponsored by the USAF School of Aerospace Medicine, Brooks AFB, Tex., Sept. 21-24.

1965 IEEE Conference on Military Electronics (MIL-E-CON 9), Washington Hilton Hotel, Washington, D.C., Sept. 22-24.

13th Annual Communications Conference, sponsored by Institute of Electrical and Electronics Engineers (IEEE), Cedar Rapids, Iowa, Sept. 24-25.

Advanced Incentive Contracting, sponsored by NDEI, New York City, Sept. 28-30.

1965 Fall National Symposium of the Society for Information Display, Commodore Hotel, New York City, Sept. 29-30.

Twelfth National Vacuum Symposium, sponsored by American Vacuum Society, Statler-Hilton Hotel, New York City, Sept. 29-Oct. 1.

OCTOBER

First International Water Desalination Exposition and Symposium, sponsored by U.S. Department of State, Department of the Interior, and Atomic Industrial Forum, Inc., Sheraton-Park Hotel, Washington, D.C., Oct. 3-9.

20th Annual Instrument Society of America International Conference and Exhibit, Ambassador and Biltmore Hotels and Sports Arena, Los Angeles, Oct. 4-7.

Aeronautic and Space Engineering and Manufacturing Meeting, sponsored by Society of Automotive Engineers, Statler Hilton Hotel, Los Angeles, Oct. 4-8.

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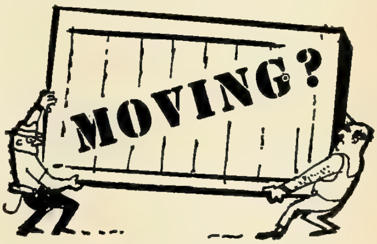

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The Naked Country

THE RUSSIANS now are engaged in a major effort to make their strategic missile strength credible.

One phase of this effort was the public showing of Soviet strategic missiles during the May 9 parade in Red Square, including the 120-ft. "Brezhnev Blockbuster" ICBM, which the Russians described as solid-fueled (M/R, May 17, p. 16). The Soviets also displayed a smaller weapon U.S. experts believe to be similar to the American *Minuteman*.

At the same time, the Soviets showed on Moscow television a film demonstrating both silo launches and underwater launches. Stills from this film appeared in a recent issue of the Soviet magazine *Ogonyok* and were reproduced in this magazine last week (M/R, Sept. 13, pp. 16-17).

Particularly interesting are the photographs of Russian anti-ICBM projects. Combined with the effort to make the strategic deterrent credible, this emphasis on A-ICBM's strengthens the second-strike posture now adopted by the Soviet Union.

It highlights at the same time the U.S. failure to push ahead with its own anti-missile program. The question can be raised, of course, as to why the U.S. needs to carry the *Nike-X* into the operational stage if the Russians no longer are threatening with a missile force of solely a first-strike nature.

The answer, obviously, is that the second-strike position is one of intention only and the same force can be used for a first strike should such a decision ever be made.

Another requirement for an operational *Nike-X* is to counter the threat of a Chinese attack. Our own experience indicates that A-ICBM lead time is considerably longer than that required to develop and deploy a first-strike ICBM. Therefore, the time to prepare a defense against the Chinese weapon is before it appears.

One argument which has been used in the Pentagon against *Nike-X* is that it would be de-stabilizing to the hoped-for U.S.-Soviet *détente*. The Russians obviously have been afflicted with no such concern. Now that they are proceeding openly with their A-ICBM effort, the U.S. can do the same without any unsettling effect—as, indeed, it could have done all along.

In fact, the indicated extent of the Russian anti-missile effort must raise the question of whether the U.S. has been left in a naked position in regard to its own anti-missile defenses.

Secretary of Defense McNamara can make the point that the delay in deployment of the *Nike-Zeus* system meant that the improved *Nike-X* now is available without waste of the funds that would have been expended on *Nike-Zeus*."This is true." *We also can save more money by holding off on *Nike-X* until we have the option of *Nike-Y* and *Nike-Z*.

This is an extremely dangerous gamble in the name of economy. It can leave us with the promise of weapons to fight tomorrow's war but totally unprepared for what may happen today. That is exactly the case with our anti-missile defenses at this time. (CAPT There is a substantial force of Soviet missiles pointed in this direction, both land-based and sea-based, with nothing between them and us but a state of mind called deterrence. PLUS/SOME POLARIS SUBS CALLED RICKOVER - THE-RE DETE

Our tremendous retaliatory strength serves as a shield, of course, but it is a shield which is no protection whatever against incoming hardware. There must be an anti-missile defense to go with it.

The Russians realize this and the time is long overdue for U.S. defense leaders to come to the same sensible conclusion.

BY MUCH THE SAME reasoning, we have been left naked on another and related front. We read with interest that the Army is convinced any deployment of *Nike-X* must be accompanied by development of a weapon to protect the *Nike-X* launch sites. *Nike-X* can protect itself against ballistic missiles. The Army, however, is concerned about "the threat from air-breather or aerodynamic devices launched against *Nike-X* sites through the lower atmosphere with relative immunity to radar detection."

If the description sounds familiar, it is because the Army is alarmed about a Soviet low-altitude supersonic vehicle, a counterpart of the American *LASV*. Dept. of Defense thought so little of *LASV* it dismantled a substantial U.S. development effort in July, 1964 (M/R, July 13, 1964, p. 13).

Yet, we now find the Army so worried over Russian development of the same weapon that a substantial *SAM-D* missile program has been established to counter the threat. The question must be asked: If *LASV* is such a feasible weapon for the Soviet Union, why was it not feasible for the U.S.? The only U.S. effort in this field remains a low-level program on a chemically powered version being studied as part of the Navy Advanced Sea-based Deterrent.

LASV was cancelled by DOD in an abrupt about-face despite substantial investment in development of its Tory II-C nuclear power plant, a program proving out exceptionally well technically.

Basis for the cancellation was DOD's decision that there was "no specific military requirement." Dr. Edward Teller, the respected nuclear scientist, condemned the cancellation as the "biggest mistake we have made since the years following the war when we failed to develop the ICBM."

We agree completely. It is true that major weapon systems have become so expensive it is impractical to fund all of those that appear to have promise. But we find no logic in a policy that leaves us naked before a ballistic attack and bereft of a weapon so effective against missile and anti-missile sites that we feel a defense against it is imperative.

William J. Coughlin

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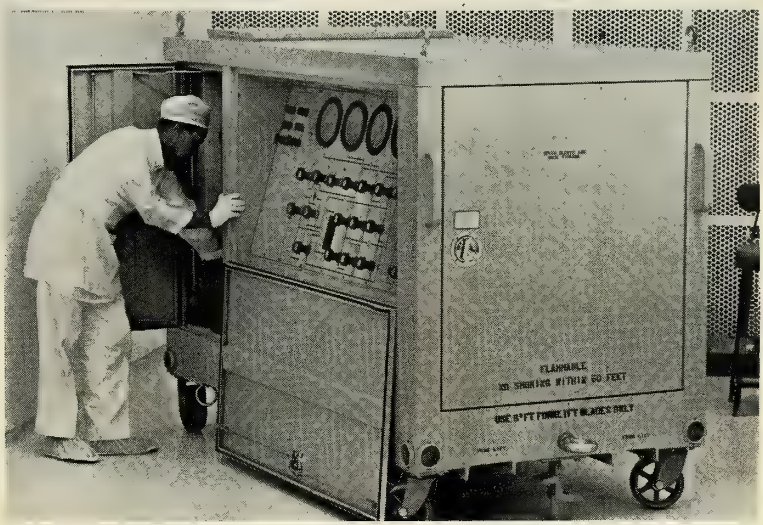
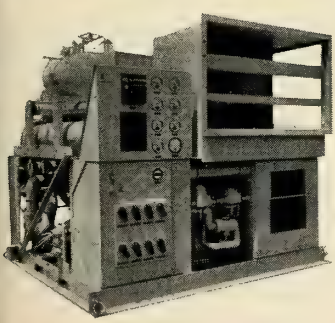


For example, look at the Surveyor spacecraft propellant fill and conditioning system we built for Hughes under contract to the Jet Propulsion Laboratory for NASA.

Not only does it have some exceptional design features, but we completed it weeks ahead of time on a tight delivery schedule.

The system is completely mobile and self-contained. It cleans, flushes and purges the spacecraft's vernier propulsion system, checks out the pneumatic components, and fills the tankage with monomethylhydrazine hydrate fuel and nitrogen tetroxide oxidizer.

With these toxic propellants we need a safe, effective vapor disposal system. So, in keeping with the compactness of the system, we designed small, efficient units and put them inside the carts.



Without any external propellant disposal facilities whatsoever, we keep the toxic vapor level to less than 10 parts per million, which makes it completely safe for operating personnel.

These are the units in the system:

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Purge Carts (shown above) flush the spacecraft propellant system with solvent, purge with nitrogen, then evacuate and dry the system. Carts have self-contained vapor disposal systems.

We also make Propellant Thermal Conditioning Systems. The one shown at left is for the propulsion system on the Apollo spacecraft service module.

This compact system provides temperature control for batch-stored propellants, and propellants that are being transferred to the spacecraft.

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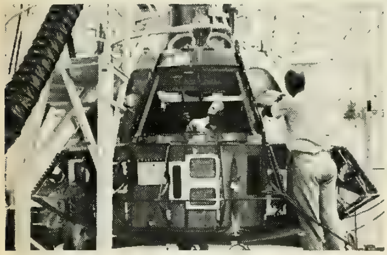
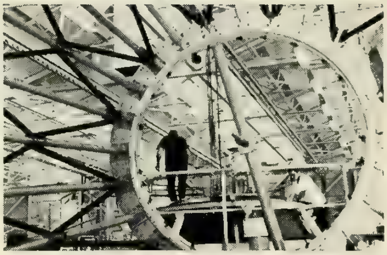
This is how North American Aviation is building the spacecraft that will take three Americans to the moon and return them to earth



The inner shell. At NAA/Space & Information Systems Division, the inner crew compartment of an Apollo command module takes shape. This leak-proof, pressure-tight shell is made of 2014 T6 alloy, 40% stronger and lighter than commonly welded aluminum alloys. To weld this structure, NAA made epic advances in tooling technology.

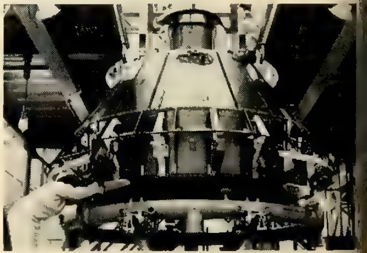


Precision jig. Shaping one Apollo crew compartment requires seventy giant tooling jigs similar to this one. Each jig is built to exact measurements, optically checked. This is why North American Aviation fabricators can hold to tolerances as minute as .010 inch on a space vehicle that stands 14 feet high, with a 13-foot base diameter.

Honeycomb structure. Strips of meta
honeycomb must be cut to exact dim
sions and bonded to surface of crew c
partment. Over the honeycomb go sheet
aluminum alloy to form a tough, lightwei
sandwich panel. Honeycomb technolo
using aluminum, was first developed
North American for the F-86.

The outer shell. The other main part of the command module is a heat-proof stainless steel honeycomb shield which fits over crew compartment. The two shells join early in the fabrication process for an exacting compatibility test. This remarkable stainless steel honeycomb technology was first developed by NAA for the XB-70.

Heat shield. Bolted to bottom of inner crew compartment, this shield must bear re-entry temperatures as high as 5,000°F. The outer shell then leaves NAA to be covered with the ablative heat shield. Ablative material is held in a fiberglass honeycomb matrix providing positive attachment method to assure high thermal-structure reliability.



Final assembly. Mating of the two Ap
shells takes place in Building 290
NAA/S&ID. This is the world's largest cl
room—1,500,000 cubic feet of meticulou
controlled air space. Here subsystems
installed. And here the completed comm
module is tested with service module
launch escape system.

The Apollo command module is being built for NASA by North American/Space and Information Systems Division. S&ID is also building the Apollo service module and the S-II stage of the Saturn V moon rocket. North American Rocketdyne is building the rocket engines for all three stages of Saturn V.

North American Aviation

Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Science Center, Space & Information Systems

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Volume 17, Number 13 September 27, 1965

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THE COVER

First useful photograph of airglow taken from space was made by a Nikon camera aboard an Aerobee 150 sounding rocket launched from White Sands Missile Range, N.M. The probe was at an altitude of 173 km when the photo was made in November, 1964. See pp. 15, 26.

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letters

In Support of Oceanography

To the Editor:

Thank you for sending me copies of your Sept. 6 issue.

Your entire special report is a distinctive contribution to general knowledge of the technological advances being made by industry in the marine environment and of the problems faced by industry in its finding expanded markets for continued advances.

As you correctly state in your article on pending legislation, S. 944 is the only oceanographic bill that has passed the Senate this year. The bill does, as you state, propose a cabinet-level National Council on Marine Resources and Engineering Development. It does more than that. It provides that the Council shall have an independent staff headed by an Executive Secretary appointed by the President, similar to that of the National Aeronautics and Space Council, and a Commission on Marine Science, Engineering and Resources composed of 15 members appointed by the President, which may include five representatives from Government, five from industry and five from universities or institutions engaged in marine science pursuits. In other words, it is the feeling of the Committee on Commerce, which reported the bill unanimously, that industry should have equality of representation in projecting a comprehensive national oceanographic program, something we do not now have.

The editorial takes the position that the Council, supplemented by an Advisory Commission, elevates the program to too high a level. It is my firm conviction, and I believe that of the Committee on Commerce and the 28 cosponsors of S. 944, that marine science development is as important as the Space and Aeronautics Council or the Water Resources Council, both established at Cabinet and top-agency level.

The President, when he was in Congress, led the successful effort to establish a Space Council. As a member of the Senate Committee on Aeronautical and Space Sciences since its inception, of the Special Senate Committee headed by the then Senator Johnson which preceded it, and as Chairman of the Senate Appropriations Subcommittee which handles appropriations for the National Aeronautics and Space Administration, I know well the value of the Council in coordinating and upgrading the space effort, and its value to the Congress. Congressional committees rely heavily on the Space Council for information in considering authorization and appropriation of NASA funding.

The President, as you know, this year supported a Water Resources Council, first initiated by a Special Committee on Natural Water Resources, of which I was a member. This also is a Cabinet-level Council.

The quotation in the article on legislation to the effect that a Cabinet-level Council would suffer because of the limited amount of time and effort its members could devote to deliberations should be reconsidered in light of Section 3(d) of S. 944. This states: Each member of the Council, except those designated pursuant to subsection (b), may designate another officer of his department or agency to serve on the Council as his alternate in his absence. Subsection (b) authorizes the President to name to the Council such other officers and officials as he deems advisable.

What S. 944 does do is place oceanography on an administrative parity with the space program, the Federal radiation program and the water resources program. It couples, for the first time, responsibility for our national oceanographic program with administrative authority. That industry desires this was reflected in testimony of industry representatives during hearings on S. 944. That the Senate desires this has been reflected by its unanimous approval of the bill.

Warren G. Magnuson
Chairman
Committee on Commerce
U.S. Senate

Since receipt of Sen. Magnuson's letter, the House of Representatives has passed S. 944, with amendments. For a summary of the changes made, see p. 20.—Ed.

To the Editor:

I have just read the "Special Report: Oceanology" in your issue of Sept. 6 and I want to congratulate you and your staff on a most thorough job of reporting.

Having just assumed my new duties as Oceanographer of the Navy, I am naturally pleased to see magazines of the stature of yours taking an interest in the Navy's work in this important field. This is particularly true because we will need all of the cooperation we can get from private industry in carrying out our programs. I hope you will continue to keep your readers informed of our activities.

O. D. Waters, Jr.
Rear Admiral, U.S. Navy
Office of the Chief of Nava
Operations

To the Editor:

For myself and for all of us here a the Oceanographic Office, I want to expres appreciation for the accurate and com prehensive job of reporting done in "Specia Report: Oceanology," in your issue o Sept. 6, 1965.

I was particularly impressed with th concise and intelligent summary of th current problems and future prospects o the national oceanographic program in th editorial which concluded your special re port. Oceanography needs this kind o reporting, and I hope that your interest i the subject will be a continuing one.

T. K. Treadwell
Captain, U.S. Navy
Deputy Commander
(Oceanography)
U.S. Naval Oceanographic Offic

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Responsible for the design of new spacecraft components from conceptual phase through detailed design, production, test and use. Includes airborne and ground telemetry, voice and video circuitry and sensor components. Requires comprehension of analog and digital circuitry, receiver and transmitter design experience and a knowledge of microelectronics. BS/MSEE or Physics with minimum of 4 years' experience.

ENGINEERS — GROUND SUPPORT EQUIPMENT
Design and development of checkout, handling, transport, acquisition display, and control equipment for orbiting spacecraft. Assignments include: thermal control equipment; propulsion system checkout; life support equipment; assembly alignment and transport equipment; sensing, control, acquisition and conditioning equipment; and special test support equipment. Requires technical degree plus 6-10 years' aerospace experience.

ENGINEERS — SIMULATION
Responsible for analysis specifications, monitoring and evaluation of crew equipment and simulation systems design from the conceptual to operable stage. Will develop simulation test plans, implement their operation and evaluate resultant data. Provide thermal control systems engineering, training systems engineering, and crew operations integration. Knowledge of software simulation systems and programming and operation of analog/digital computers. Engineering degree plus 4-6 years' applicable experience required.

HUMAN FACTORS PSYCHOLOGISTS
Human factors analysis of AGE, AVE, and crew accommodation equipment for manned space vehicles. Evaluation of adequacy of design as regards reliability, safety, service and maintenance. Determine optimal work-place layout, displays and controls requirements, lighting conditions and support-restraint devices. Establish training and simulation requirements and define spacecraft checkout interface. Relate anthropometric, pressure suit and restraint data to determination of crew visual-manual function envelope. Requires BS/MS Psychology or Engineering and 4-8 years' aircraft and/or space vehicle experience.

ENGINEERS — LIFE SUPPORT SYSTEMS
Analysis, design, development, test and evaluation of life support equipment which will enable men to perform in space for extended periods of time. Subsystems include cabin pressure control, thermal control, pressure suit, support equipment, waste collection and personal hygiene, safety and survival. Requires technical degree and direct comparable experience.

SURVIVABILITY SYSTEMS ENGINEERS
Plan, direct and contribute to survivability studies of advanced space systems subject to natural and man-made radiation environment. Efforts include: design and circuit analyses of transient radiation effects on electronic systems; design and conduction of radiation tests on components and subsystems; analysis of the generation mechanism, transmission and interaction of various forms of energy from a nuclear weapon. Requires BS/MS EE, ME, or Physics with several years of experience in either circuit design, electronic hardening techniques and a familiarity with nuclear weapons technology.

You are invited to inquire further by writing to: Mr. J. S. Barson, Room 394J-4.
Valley Forge Space Technology Center, General Electric Co., P.O. Box 8555, Philadelphia, Pennsylvania.

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The Countdown

WASHINGTON

DOD Expected to Seek Extra $7-10 Billion

Dept. of Defense is likely to ask Congress in January for a supplemental Fiscal Year 1966 request of $7-10 billion, according to Sen. Leverett Saltonstall (Mass.), ranking Republican on the Senate Appropriations and Armed Services committees. This jibes with estimates released earlier by Sen. John Stennis (D-Miss.), acting chairman of the Armed Services Committee and the Appropriations Defense subcommittee.

Voyager Decisions Ready for Announcement

NASA is expected to make public very soon plans for the *Voyager* program growing out of recent decisions made by Administrator James E. Webb prior to submitting the agency's FY 1967 budget request to the Bureau of the Budget. One possible change in the current program would be to send a *Mariner*-type spacecraft into the Martian atmosphere to get a better reading on its pressure. Further data is needed before the design of a landing capsule can be frozen.

AES Shortened to AA; Marshall To Integrate

NASA has officially changed the name of its *Apollo* Extension Systems (AES) program to the simpler *Apollo* Applications (AA). At the same time, it has confirmed that Marshall Space Flight Center will be responsible for payload integration of AA.

Gemini 6 Preparations Proceed . . .

Electrical interface tests were completed on the *Gemini 6* spacecraft and its *Titan* launch vehicle at Cape Kennedy ast week. The *Gemini-Titan* and the *Atlas-Agena* will undergo a simultaneous countdown during wet-mock simulations scheduled for the second week in October.

. . and Gemini 7 Will Soon Join Her

The *Gemini 7* spacecraft will begin simulation flights at McDonnell Aircraft Corp. in St. Louis this week in final ests prior to acceptance. It will be flown to Cape Kennedy "shortly before the *Gemini 6* mission," a NASA Manned Spacecraft Center spokesman said.

Volunteers Testing Gemini 7 Diet

A "caloric water and protein balance study" is in progress t Wright-Patterson AFB, Ohio, under guidance of Manned Spacecraft Center's Dr. Paul LaChance, to verify hardware nd procedures for waste management proposed for the 4-day *Gemini 7* mission in late December. Four volunteers will be sustained on a controlled diet of bite-sized and reydratable space food over a six-week period. Midway hrough the study, they will enter an altitude chamber for wo weeks. This will be followed by two weeks of "postight" checks. Careful measurement of calcium intake and oss through body fluids—one of the *Gemini 7* medical experiments—will be made on each subject.

GT-7 Will Stick to Stored Drinking Water

Astronauts Frank Borman and James Lovell will not rink water produced by the fuel cell during their 14-day *GT-7* mission. Instead, they will draw on a supply of about 00 lbs. of fresh water in compressible bladders placed inside the fuel cell water storage tanks—the same procedure followed in *GT-5*. However, tankage for the 14-day water supply has been doubled over that available on *GT-5*. As in the earlier mission, tanks will be sealed, ruling out any dumping of excess water. Meantime, NASA's Manned Spacecraft Center is working out a more accurate method for metering water consumption during the flight. During *GT-5* this was accomplished by measuring "gulps."

Clark U. To Get Goddard Memorial

The House of Representatives has passed a resolution to erect a memorial to rocket pioneer Robert H. Goddard at the site of much of his work—Clark University in Worcester, Mass. Arrangements will be handled by NASA, with advice from the Federal Commission on Fine Arts.

INDUSTRY

Doolittle Appointment Sharpens Aerospace

Latest move in a series of apparent efforts to improve the image of Aerospace Corp. is the naming of Lt. Gen. James Doolittle (USAF Ret.) to be vice chairman of the board and chairman of a nine-man executive committee. Since the scalding report on its activities by the House Armed Services Investigations Subcommittee, the company also has diligently reported on its use of fees from the Air Force. Previous failure to do this was an especially sore point with the subcommittee.

Ball Bros. Studies Apollo Telescope

Ball Brothers Research Corp. is investigating the mounting of a telescope, perhaps as long as 12 feet, in the *Apollo* spacecraft. If approved, the instrument would be flown in the currently approved *Apollo* program as well as in upcoming extended *Apollo* flights. The NASA study contract is for $117,175.

ITT, Western Union May Cover GT-6 Recovery

NASA seems to have no serious objection to proposals to provide live television coverage of the recovery of the *Gemini 6* astronauts. It's reported that the Navy may also approve installation of a transportable ground station aboard the aircraft carrier USS Essex for TV transmission via *Early Bird* satellite. Both ITT World Communications, Inc., and Western Union International have requested permission from the Federal Communications Commission to carry out the transmission. Either would have to depend heavily on cooperation of the Communications Satellite Corp., which is asking for overall control of the operation.

INTERNATIONAL

French Step Up Space Experiments

France may be accelerating its fledgling program of space experimentation, according to the Paris newspaper *Le Monde*. First launch of the *Diamant* vehicle may now come at the end of November, before the French presidential election, and may include an attempt to put the *A-1* satellite in orbit, according to *Le Monde*. In case of an *A-1* failure, it adds, a second launch may take place before Dec. 5. Mid-January is quoted as the deadline for orbiting the *D-1* satellite, and *D-1B* may be launched at a later date. In addition, the *FR-1* satellite is to be orbited from Vandenberg AFB, Calif., on Dec. 8, utilizing a U.S.-supplied *Scout* booster.

CAREER
APPOINTMENTS

ENGINEERS
CHEMISTS

Engineers and chemists are invited to apply for appointments to the Chemical Propulsion Information Agency operated by The Johns Hopkins University Applied Physics Laboratory for the Departments of the Army, Navy, and Air Force, National Aeronautics and Space Administration, and Advanced Research Projects Agency. CPIA is responsible for acquiring, analyzing and disseminating the world's literature in propulsion research, development, test and evaluation.

Positions involve reading, abstracting, and indexing progress reports generated by a large number of principal investigators in many areas of chemical propulsion research; frequent personal contact with these scientists and engineers; and liaison with United States Government technical contract monitors. Respondents must be capable of synthesizing information for publication from analysis of these data. A bachelor's degree in engineering or chemistry and several years of related experience such as rocket engine design, static test, or propellant formulation are desirable.

The Applied Physics Laboratory is located in a residential suburb of Washington, D. C., an area well known for its beauty, high standards, and excellent public schools and universities.

Direct your inquiry to:

Mr. W. S. Kirby,
Professional Staff Appointments

Applied Physics Laboratory
The Johns Hopkins University

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The Missile/Space Week

DOD Money Bill Cleared

The FY 1966 Dept. of Defense appropriations bill finally is ready for the President's signature as both House and Senate last week acted on the conference bill.

The measure now totals $48.887 billion, which is $10 million more than the Senate version, and $1.698 billion more than that of the House. The substantial increase from the House amount reflects the fact that the $1.7 billion emergency fund for Southeast Asia was included in the Senate bill only.

While the conference bill included no changes in line items in the missile/space field (both Houses were in agreement on most of the items in research, development, test and evaluation and procurement in this area), a few related points were modified. One of the major changes was the decision to give the Secretary of Defense $125 million for an R&D emergency fund, rather than the $15 million voted by the House and the $100 million awarded by the Senate.

Both the initial House and Senate reports had rapped the DOD practice of using the fund to finance low-priority programs, and of expending considerable amounts from the emergency fund during the last month of the fiscal year to obligate the money before the appropriation expired.

In explaining the change to the higher amount, Rep. George Mahon (D-Tex.) pointed out that the additional money is intended for exploitation of unforeseen scientific and technical breakthroughs that occur after the year's budget has been acted on.

Saturn IB-3 Static Tested

The *Saturn IB-3* booster is undergoing captive-firing at Marshall Space Flight Center in preparation for launch of an unmanned *Apollo* spacecraft.

After at least two firings, the booster will be returned to the Michoud, La., Assembly Facility for post-static checkout.

ABC Seeks Comsat Okay

American Broadcasting Co. has formally requested authority to own and operate a communications satellite system linking an estimated 200 affiliated television stations.

The company asked the Federal Communications Commission for permission to set up a $21.5-million system using a synchronous-orbit satellite, similar to *Early Bird.*

The request challenges the right of the Communications Satellite Corp. to be sole operator of U.S.-launched commercial communications satellites. When ABC announced an interest in its own satellite system last spring (M/R, May 24, p. 10), Comsat officials objected. Although it expressed a willingness to cooperate on the ABC project, the corporation maintains that, under the Satellite Communications Act of 1962, it has an exclusive right to operate commercial satellites in the U.S.

ABC's proposed system would be developed by Hughes Aircraft Co., which built Comsat's *Early Bird.* It would have a five-channel capacity with one channel available without charge to educational television stations.

New Ames Director Named

H. Julian Allen will take over as director of the Ames Research Center Oct. 15.

He replaces Dr. Smith J. DeFrance, who is retiring. Allen is currently assistant director for astronautics at Ames.

NASA Discusses Transport Pact

NASA is negotiating with Aero Spacelines, Inc., for use of the "Super Guppy" aircraft to transport such cargoes as the Saturn S-IVB stage, *Saturn IB* and *Saturn V* instrument units and the Lunar Excursion Module adapter.

The $1.5 million contract would provide transport service for 1 year with provision for three 1-year renewal options.

Waste Disposal Study Finished

The lastest of the California aerospace industry studies on state problems reports that systems management techniques are the only logical method of coping with waste management problems of the future.

According to the study done by Aerojet-General, costs of disposal in California will climb to the multibillion-dollar level in the next 25 years. The many state and local bodies involved in regulating, collecting and disposing of different wastes should be brought together by systems analysis, Aerojet scientists and

Over 300 new openings for graduate engineers at Hughes Aerospace Divisions in Southern California

Important assignments are immediately available for qualified engineers on new and continuing aerospace/missile programs such as: EARLY BIRD, SURVEYOR, AIM-47, TOW, WALLEYE, SYNCOM, PHOENIX, ADO-51, VATE, MANNED ORBITING SYSTEMS, ADVANCED TECHNOLOGY SATELLITES, ADVANCED SPACE GUIDANCE & FIRE CONTROL SYSTEMS . . . and many others.

If you are interested in building an exciting and rewarding career working in a climate of opportunity on expanding projects and tomorrow's technologies, contact us immediately. You will receive a reply within one week.

AEROSPACE & WEAPON SYSTEMS ENGINEERS

The assignments outlined below represent just a few of the more than 300 openings currently available for qualified engineers and scientists who hold accredite degrees and U.S. citizenship, and have several years of applicable, professional experience.
Consider these representative openings:

LOGICAL DESIGNERS

Openings exist for logical designers experienced in mechanizing system requirements and in preparing and verifying detailed Boolean equations, inducting trade-offs to optimize costs and reliability as affected by logic; mechanizing, coordinating and optimizing of conflicting requirements from circuit design, physical design, programming and the customers. Requires a minimum of 3-5 years of detailed logic design.

CIRCUIT DESIGN ENGINEERS

For the design of logic circuits; memories using ferrite cores, biax, magnetic thin films and physically alterable NDRO; many forms of input-output devices; high-reliability, low-power circuits for spacecraft VHF and UHF counters.

COMPUTER DESIGN AUTOMATION

Programmers who are proficient with Fortran IV and related languages are required to design programs, relieving the digital systems designer of as many routine tasks as possible. Besides programming experience, it is necessary that applicants be conversant through experience with the design problems in the areas of logic design, circuit design and physical design.

RADAR SYSTEMS ENGINEERS

For conceptual and preliminary design of advanced, multi-mode tactical radar systems — with emphasis on either display, control and data processing or on special signal processing techniques.

SPACECRAFT LAUNCH ENGINEERS

Electronics Engineers with experience in operation and maintenance of digital or communications data acquisition and handling are urgently needed to perform satellite spacecraft checkout and launch readiness for our SURVEYOR Program. Candidates will be trained in Los Angeles and required to travel. Permanent assignments are available in the San Diego, Los Angeles and Cape Kennedy areas.

CONTROL SYSTEM ENGINEERS

For the design and development of pointing servos for airborne and spaceborne antennas, optical sights and IR seekers. Normal duties will include interpretation of customers' requirements, design analysis and test of servo loops, specification of circuit requirements, circuit design and occasional liaison.

Please complete the attached card immediately so that we may become acquainted with your background, qualifications and interests. Or, if you prefer, forward your resume to:

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engineers said. They suggested a 10-year program to develop and put into operation an overall waste management system that would be integrated into existing political, social and economic conditions.

Shots of the Week

The Soviet Union on Sept. 18 used a single booster to set five *Cosmos* series satellites into orbit. The satellites were numbered *86-90.*

- Two Air Force *Athenas* were launched within hours of each other Sept. 13 from Green River, Utah, into the White Sands Missile Range, N.M. Of 13 *Athena* vehicles launched in the past two months, 10 have been successful. All missions were not accomplished on the other three flights, but vehicle performance is said to have been good on all flights.
- The Air Force launched a satellite aboard a *Thor-Agena* booster from Vandenberg AFB, Calif., Sept. 22. The launch was termed successful, but the purpose was not revealed.

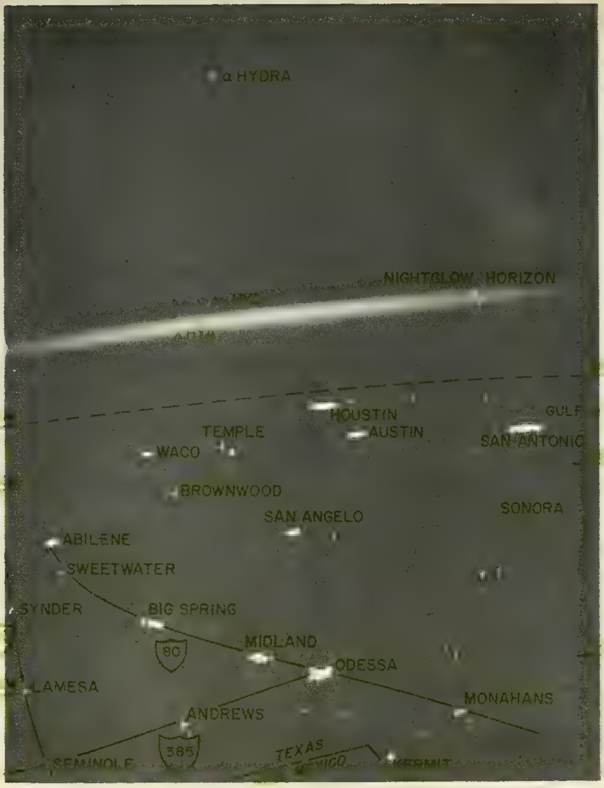
NASA Cuts Hydrogen Purchase

NASA will cut back liquid hydrogen supply requirements for its West Coast operations after the end of this year.

The space agency announced that it will not renew its contract with Union Carbide Corp.'s Linde Div. plant at Ontario, Calif. The plant has a production capability of 30 tons per day. The NASA requirement of 90 tons per day will be met by Linde's 60-ton plant at Sacramento, Calif., and the 30-ton plant of Air Products and Chemicals, Inc.

Boeing, IAM at Odds

Negotiations between The Boeing Co. and International Assn. of Machinists representatives were continuing the middle of last week in Seattle with little indication of progress toward ending the strike that had idled IAM workers at Boeng locations throughout the country, ncluding Cape Kennedy.



Sounding Rocket Camera Captures Nightglow Photo

AN AUTOMATIC Nikon camera aboard an Aerobee 150 sounding rocket launched from White Sands Missile Range recorded this, the first useful photograph of the nightglow (airglow at night), during November, 1964, at local midnight. Tri-X film was used, with a three-second exposure. Nightglow results from the recombination of molecules energized by the Sun during the day. The overlay identifies city lights and stars. The camera was pointed east-southeast over Texas. Distances noted in margins are measured from launch site, with the 1,500-km line also representing the Earth's horizon. The rocket was at an altitude of 173 km when the photo was taken, and the distance from the Earth's horizon to the center of the nightglow is 90 km. See story, p. 26.

GTA-8 Crew Named

NASA's Manned Spacecraft Ceer has named civilian astronaut Neil A. Armstrong and Air Force Major David R. Scott prime crew for the *Gemini-Titan-Agena 8*—a 2- to 3-day endezvous and docking mission, with xtended extravehicular activity EVA), scheduled in "the second uarter of 1966."

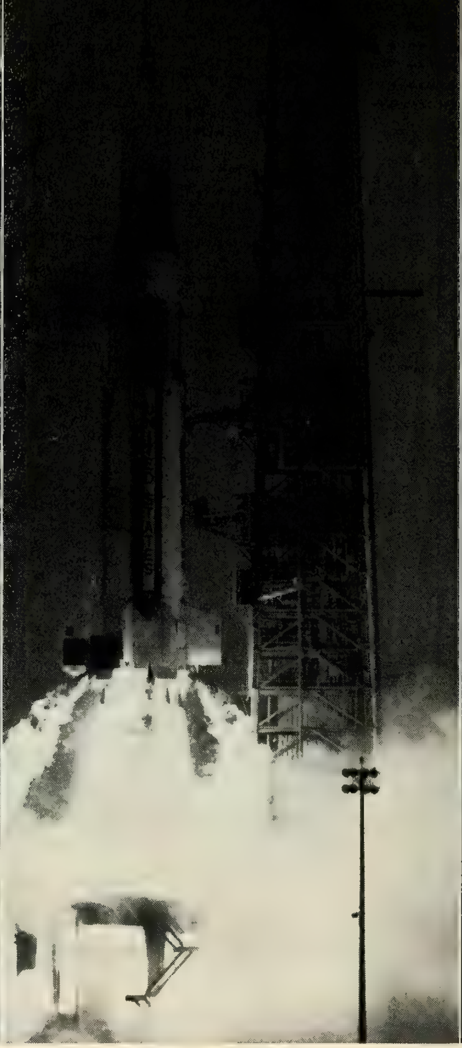
Astronauts Charles Conrad, Jr., and Richard F. Gordon, Jr., were selected to back up the pilots.

According to an MSC spokesman, several rendezvous exercises will be attempted during the mission. One will be "along *GTA-6* lines"; afterward, the spacecraft will back away from the *Agena* and the ground will command the target vehicle into "an area unknown to the crew." During the second rendezvous, the spacecraft may approach the *Agena* from above using the Earth's background as the frame of reference during the terminal phase maneuvers.

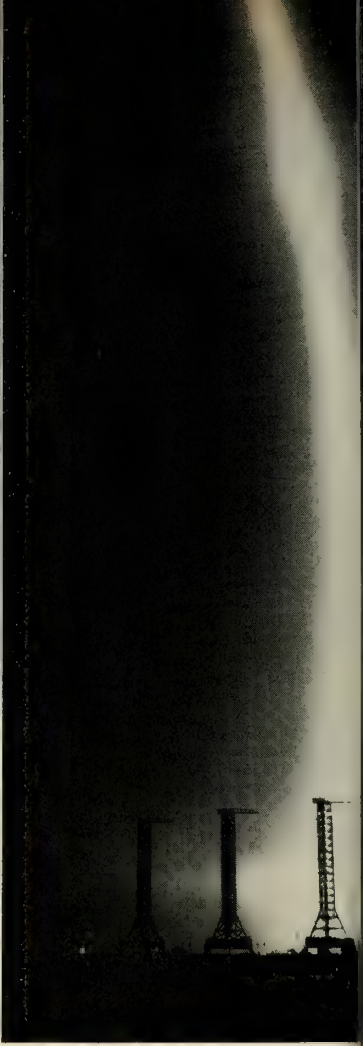
"Long-duration" EVA is also planned. Scott will remain outside the spacecraft through the day and night side of the orbit, evaluating umbilicals and tethers, retrieving experimental data-collection packages brought up into orbit on the *Agena* and working with torqueless tools on a special work panel, which will be pulled out from the side of the spacecraft adapter.

He will practice donning a back pack containing a 1-hour supply of oxygen, which will be stowed in the adapter section. After switching to the back pack supply of oxygen, he will move away from the spacecraft on a tether "up to 75 ft. in length" to work with a maneuvering gun and to check out the RF communications link. The exercise is in preparation for DOD's Astronaut Maneuvering Unit (AMU) experiment scheduled for *Gemini 9*.

SA-6 (May 28, 1964)



SA-7 (Sept. 18, 1964)

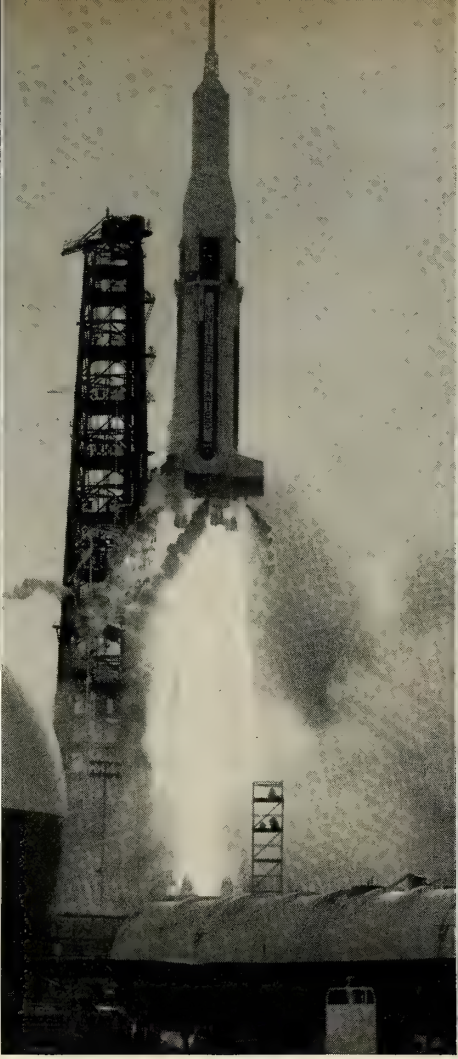


SA-8 (May 25, 196

When the National Aeronautics and Space Administration's Saturn IB program kicks off next year with the launch of Saturn SA-201, Bendix ST-124 inertial platforms will play a key role in guiding the mighty rockets on their missions—just as Bendix ST-124's have done with flawless performance on the last five Saturn I shots. And you can expect Bendix platforms to provide the same kind of performance on the Saturn V program that's scheduled to carry U. S. astronauts to the moon.

A high order of accuracy and dependability has been ty
cal of all Bendix inertial guidance work. In addition to th
Saturn record, there have been no recorded in-flight fa
ures of our inertial guidance system in 89 firings of Army
Pershing missile. Our 16 PIGA liquid-floated Pendulo
Integrating Gyro Accelerometers used on the USAF's a
vanced Minuteman have been described as providing o
of the most accurate velocity measuring systems i
existence. To state it simply, we have a record of expe

A-9 (Feb. 16, 1965)



SA-10 (July 30, 1965)

For the next demonstration of Bendix inertial guidance capabilities, watch the Saturn SA-201 shot.

nce and capability in inertial guidance that few, if any, an match: we are in production on inertial sensors of oth liquid and gas-floated design; our inertial products ange from individual sensors to stable platforms to com-lete systems; our in-flight performance has consistently on high level praise for accuracy, dependability and eliability; our work embraces NASA, Army and Air Force rograms.

you have an inertial guidance requirement, contact the people who offer diversity of design coupled with a performance record of proven integrity. The Bendix Corporation, Eclipse-Pioneer Division, Teterboro, New Jersey.

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Douglas Reopens MOL Subcontracting

Vice President Able says action taken 'for health of program'; he also urges development of lifting-body vehicle starting in '70

SUBCONTRACTING on the Air Force's *Manned Orbiting Laboratory* (*MOL*) has been reopened for consideration, according to an official of Douglas Aircraft Co., prime contractor for the system.

C. R. Able, Douglas vice president heading the Missile and Space Systems Div., said that competition for major subsystems has been reopened "for the health of the program." It appears that proposal team members will not necessarily have a berth in the program, and losing team subcontractors will still have an opportunity to get in on it.

In a speech at the National Space Club in Washington, D.C., Able also stressed the need for a lifting-body spacecraft for what he said would be the prime missions of the future—logistics, re-entry research and space rescue, and intelligence.

- **Future**—The Douglas vice president said the nation is "once more" at a point where crucial decisions concerning future aerospace exploration should be made—decisions which will be far more binding for a far longer period than those in the past.

Even with present limited knowledge, he said, the requirement can be foreseen for national testing of about 32,000 hours in space. The *Apollo* Applications program (AA) as presently conceived would include up to four 30-day flights a year between 1968 and 1972, making about 10,000 hours of test time available—split about evenly between Earth-orbit and lunar operations.

Of this, he pointed out, about 2,000 hours would be devoted to actual hardware experiments, the other used up in crew functions and housekeeping activities.

However, by improving systems now in use or under development, he said, orbital stay time could be extended well beyond 30 days. By starting development work before the 1970's, vehicles could be made available to give 20,000 hours of useful experimental time in space from 1972 to 1977.

Able stressed the need for a reusable logistics vehicle which could be refurbished and reused at about 10% of the cost of the original vehicle, compared with the 60% cost estimated for reuse of a *Mercury* or *Gemini* spacecraft.

- **Lifting body**—Future needs for logistics, re-entry research and space rescue and intelligence appear to dictate the development of a lifting-body re-entry vehicle, Able said.

One spacecraft could be developed for all three missions, he said, and also be large enough to be used as the support craft for an advanced space station or lunar base.

If development of such a lifting re-entry test vehicle were initiated in 1970, Able said, it would be available in the last half of that decade for support of an expanding orbiting laboratory program or lunar exploration program. In addition, he said, it would reduce the operating cost of those projects by a factor of two.

Able disclosed that Douglas invested very heavily in research and facilities to be ready for the *MOL* competition, allotting some $35 million to the Space Systems Center, where *MOL* as well as *Saturn* S-IV and IVB work is headquartered. He said the company is well into the second phase of a three-step building program which is master-planned to 1970. ■

House Passes Bill to Expand Oceanographic Effort

THE HOUSE HAS PASSED legislation on oceanography which will give new direction and impetus to the field, but has amended the Senate-passed bill to exclude a section calling for establishment of a high-level council on oceanography.

Passage by the House marks the first time such a bill has managed to get through both houses of Congress. In recent years, House bills were voted down or were not taken up by the Senate.

Most of the points in the Senate bill (S. 944) introduced by Sen. Warren Magnuson (D-Wash.) were adopted by the House, including provisions for a commission to be appointed by the President to "make a comprehensive investigation and study of all aspects of marine science in order to recommend an overall plan for an adequate national oceanographic program that will meet the present and future national needs."

A fund of up to $1.5 million is provided for the activities of the commission, which is to make its report in 18 months, and to strengthen the staff of the Interagency Committee on Oceanography.

However, in apparent reaction to criticism from some experts in the field and to editorial comment (M/R, Sept. 6, p. 70), the committee struck out a section which would authorize establishment of a statutory Cabinet-level Council—with assignment of responsibilities at the discretion of the President. The House managers of the bill explained that the composition of such a committee would be virtually the same as that of the Federal Council of Science and Technology, duplicating responsibility and overburdening extremely busy men.

- **Water gap?**—During debate on the bill, Rep. Hastings Keith (R-Mass.) said that the Soviet Union now ranks first in oceanography, with approximately 230 oceangoing ships conducting research in the marine sciences. The United States, he pointed out, has less than half that number. Soviet manpower in the field was estimated at 5,000-8,000, while the United States numbers about 2,500, he said.

The field of oceanography was characterized by Rep. Bob Wilson (R-Calif.) as being in the same state as was space research before NASA was created. He said that under the bill problems of having oceanography parceled out among 22 different bureaus in nine departments or agencies can be worked out, duplication avoided and proper attention given to needy projects.

Bids Asked on Apollo Experiment Bed

Two firms to be selected for $375,000 studies of pallet; second phase will include incentive development contract

THE SPACE AGENCY has asked 36 firms to submit bids in the first step leading to development of an experimental pallet for the *Apollo* spacecraft.

The initial procurement action calls for four-month study contracts including preliminary design, detailed engineering specifications, construction of mockups and a firm cost proposal for the second phase of the program.

The second phase, according to the Manned Spacecraft Center, will provide a cost-plus-incentive-fee contract covering development of the pallet.

Two firms will be selected for the first-phase study contracts, which will be worth $375,000 each. One of the firms will be named later as the prime contractor for the pallet development.

The pallet will be used to carry experiments which will be flown during long-duration Project *Apollo* flights.

It will weigh about 5,000 lbs. and occupy one of the six equipment bays in the spacecraft's Service Module. Its first flight is expected to be made in 1968, when the first *Saturn V/Apollo* flights are scheduled.

Specifications call for the pallet to have a lifetime capability of two weeks, during which it will be continuously monitored and controlled by the crew.

Plans call for some of the experiments to be returned to Earth for detailed study of their findings. As a result, they will have to be retrieved by the crew through extravehicular activity (EVA).

MSC said it is possible that some experiments may require extension booms up to 25 ft. long. Experiments not requiring EVA will record data and transmit information back to the ground tracking network via VHF and S-band links.

- **Test list**—NASA said some of the experiments under consideration include: radar scattering; cross-section measurements of terrain; temperature sounding of the atmosphere; ultraviolet mapping of the skies and stars in the 1,230-1,700 Angstrom band; searching for X-ray sources outside the solar system; detection and mapping of gallactic gamma-ray sources; nuclear emulsion detection of particles; measurement of atmospheric iodine and its possible relationship to marine life at the ocean's surface; zero-gravity studies of the physical properties of liquids and solids; and studies of fog otolith functions (bioelectric action of the vestibular nerve) during weightlessness and acceleration.

The 36 firms invited to submit bids were: AC Electronics; Avco; Ball Brothers; Bell Aerosystems; Bendix; Boeing; Brown Engineering; Collins Radio; Chrysler; Douglas; General Dynamics; General Electric; General Precision; Goodyear Aerospace; Heat Technical Lab; Honeywell; Hughes Aircraft; IBM; Lockheed; Ling-Temco-Vought; McDonnell; Martin; Melpar; North American; Northrop; Philco; Pratt & Whitney; Raytheon; RCA; Republic Aviation; Ryan Aeronautical; Spacecraft, Inc.; Space-General; Sperry Gyroscope; TRW and Westinghouse. ■

LTV Flight-Testing Astronaut Maneuvering Unit

HOUSTON—The Astronaut Maneuvering Unit (AMU) being developed for the Air Force is undergoing flight qualification tests at Ling-Temco-Vought, Inc. in Dallas, and will be delivered to NASA's Manned Spacecraft Center in Houston about Oct. 15.

Manned tests of the backpack are scheduled to begin Dec. 1 in MSC's Chamber B—a 43-ft.-high altitude chamber, 35 ft. in diameter, now undergoing man-rating tests. Tests will consist of donning the AMU, which will be stowed in the adapter section of the spacecraft, activating its systems and firing the 12 hydrogen peroxide thrusters singly and in combination.

The AMU is scheduled to be used during the *Gemini 9* flight.

A modified extravehicular activity (EVA) suit will be worn during AMU missions utilizing a special combination of materials from the waist down to resist the effects of thruster plume impingement.

Tests using Chromal-R as the outer layer and a "super insulation" of 11 alternate layers of aluminized H film and glass fiber spacers have just been completed on a special thermal coverall fabricated by the David Clark Co., Worcester, Mass. Hydrogen peroxide thrusters were fired against the thermal coverall at the General Electric Co.'s Valley Forge test chamber facilities, an Air Force spokesman told MISSILES AND ROCKETS. Although the test data has not yet been completely analyzed, the material showed "no significant degradation." The combination of materials was selected by LTV.

The Air Force also reported that a minimum-reaction power tool resembling a "power lug wrench" with a number of tool attachments will be flown and used during *GTA-8*. It was designed by the Martin Co. of Baltimore under an Air Force contract and tested in zero-gravity flights at Wright-Patterson AFB, Ohio.

The astronauts will evaluate the tool and attachment on a special work panel that pulls out "like a drawer" from the spacecraft adapter equipment section. A simple tethering device attached from the spacecraft to the operator's knee will be used to prevent him from drifting away from the work area and to minimize "pendulum motion effect."

The plan calls for the astronaut to move toward the work area along a hand rail mounted to the side of the spacecraft. Before beginning the experiments, he will set up a 16mm Maurer movie camera on the adapter to view the tool operation.

The work task plate lifts up from the drawer and holds four pre-torqued bolts to be loosened with the tool and three loose bolts to be tightened to the work plate mount. An instrumented bolt will measure the amount of force imparted by the operator during bolt loosening and tightening activity and will telemeter the information to the ground.

MIL-E-CON Told Space Program Spurring General Electronics R&D

A TOP NASA official declares that the space program is forcing electronics companies to have a larger research base, whether or not they are engaged in the space program.

Dr. Albert J. Kelley, deputy director of NASA's Electronics Research Center, told the Ninth Conference on Military Electronics (MIL-E-CON) in Washington that he does not mean to imply that an electronics company must get into space electronics to compete in another segment of the electronics business.

He said, however, that companies successful in space electronics will have a firm R&D base to apply to other markets. On the other hand, he continued, companies with a large production base, but without a solid corporate research base, may find technology moving too fast.

• **Supporting evidence**—Recent changes announced at the meeting last week seemed to bear out Kelley's prediction. Next year's meeting, which will also be held in Washington, will be titled "The Aerospace and Electronics Systems Convention."

In addition to being sponsored by the miltary electronics group of the Institute of Electrical and Electronics Engineers, the convention will be sponsored by the IEEE professional groups on telemetry systems, aerospace systems and navigational electronics systems.

"You have heard of technology spin-off from space programs," Kelley said, "and you undoubtedly have seen some excellent examples." But, he said, "increased emphasis on research, closer tying in of research to end goals and shortening of the research-to-development-to-manufacture cycle may yet be the most valuable spin-off of the space program."

Kelley pointed out that from $2.5 to $3 billion of the space agency's annual budget of about $5 billion is spent on electronics.

• **Computer potential cited**—In another address before the meeting, Dr. J. K. Pierce of Bell Telephone Laboratories said that despite some 22,500 electronic general-purpose digital computers in use today throughout the U.S., users are only beginning to take advantage of their potential.

He said that it is widespread industrial and government usage, rather than scientific applications, that accounted for the $5-billion production and sales in the computer field last year. These same groups also provided more than 650,000 jobs for associated personnel.

Discussing "Automation and the Future" with particular emphasis on computer applications, Pierce asserted that reason has now taken over in computer development with better recognition of both the capabilities and the limitations of automatic data-processing and control systems. "The once general enthusiasm for making computers manifest 'artificial intelligence' is waning. Failure is one reason," he declared.

Future machines, he said, must be more adaptive and multiprogramming will have to be employed. Both speed and efficiency must be increased and simultaneous access by many users made available. In addition, simple and more powerful programming languages must be developed, particularly for novices.

• **Advanced system areas**—Discussing future application of advanced computers, Pierce predicted that such systems will be used:

—In writing, production and high-speed dissemination of reports, journals and books;

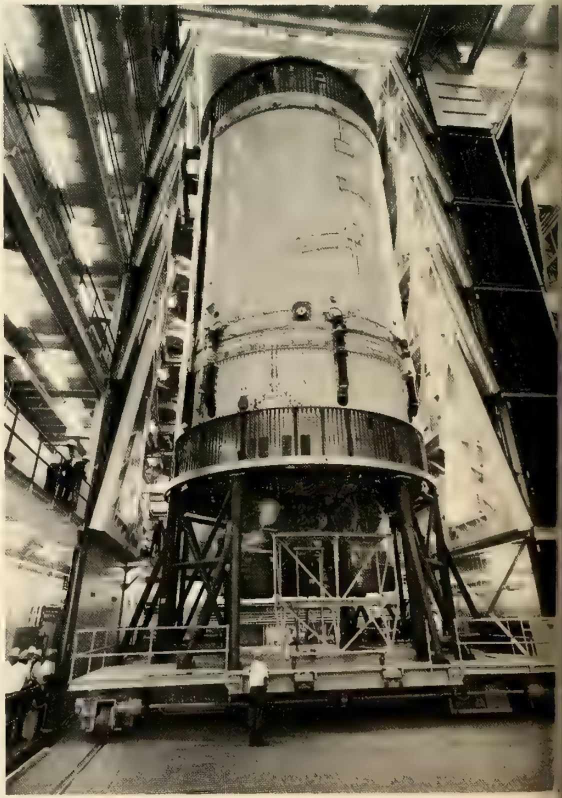
—In the classification and/or interpretation of photographic or photomicrographic data;

—In the control and production of drawings for animated motion pictures and for cathode-ray tube presentations;

—In simulations to assist in the design of complex mechanical structures or electronic and electro-optical systems (thus permitting a marked reduction in the building of experimental hardware for new equipment). ■

Saturn V S-II Stage Readied

FIRST complete test model of the Saturn V lunar launch vehicle's S-II second stage is shown before departure from North American Aviation's Seal Beach, Calif., facility for shipment via the Panama Canal to NASA's Mississippi Test Facility. There it will undergo static firing tests beginning early next year. Saturn S-II stage is produced by NAA's Space and Information Systems Div. for NASA's Marshall Space Flight Center.



Booster Revolution Foreseen at IAF

U.S. delegates describe potential of air-breathing and microwave engines; Soviets show more Moon photos, tell of Voskhod landings

ATHENS, GREECE—Breakthroughs in unconventional propulsion that could make present-day chemical rockets obsolete were outlined in papers presented at the XVIth International Astronautical Congress here.

Air Force Systems Command chief scientist Dr. B. H. Goethert told the meeting that air-breathing engines such as Scramjet show promise of fuel efficiencies at hypersonic speed which "could well revolutionize our booster technology."

J. L. Schad and J. J. Moriarty of Raytheon Co. presented a microwave rocket concept which, if attainable, would hold significant advantages over chemical rockets. They said recent breakthroughs to high-power microwave generation have made it possible to consider such rockets.

Throughout the six-day meeting, U.S. papers overshadowed in both detail and concept the presentations of a large Soviet delegation, which included *Voskhod II* cosmonauts Pavel Belyayev and Alexei Leonov, the latter the first man to "walk" in space.

Much of the ground covered, even in the American papers, was not new, particularly as regards the manned space program. Nevertheless, the openness of the U.S. attitude on future space plans contrasted with the continuing close-mouthed Soviet approach to the same subject.

The Russians drew interest with astronomer Alexander Mihailov's presentation of the remaining photographs taken recently by the Soviets of the far side of the Moon. He said these show that the marias on the unseen side are both fewer and smaller than those on the visible side. Most significant findings from the photographs are fissures in the Moon's crust accompanied by chains of craters with diameters of 10 km or more.

"I think these chains of craters can be explained only by the theory of volcanic action," Mihailov declared.

- **Proton potential**—Moscow University professor Ivan Savenko reported on measurements made by *Proton I* of heavy nuclear particles with an electronic voltage of 10^{12}v. He noted that this, the heaviest Soviet satellite to date, made it possible to carry equipment for measurements which could not be made in any other way.

Another reference to *Proton I* was made by cosmonaut Leonov. In telling a plenary session about his walk in space, Leonov disclosed that future Soviet space plans call for orbiting of manned space platforms whose crews can be changed by space ferry, prior to the initial Soviet lunar landing. This was taken by many as confirmation of the belief that Soviet emphasis in the lunar race is on Earth rendezvous, rather than the lunar rendezvous of the U.S. *Apollo* project.

Questioned later about the launch date for such an orbiting laboratory, which he had said was "not far away," Leonov declared that he could not give the date precisely. However, he pointed to the weight of *Proton I* as providing significant capability.

Presentations to the Congress by American *Gemini 5* astronauts L. Gordon Cooper Jr. and Charles Conrad Jr., and by their physician, Dr. Charles Berry, were in much greater detail than those of the two Soviet cosmonauts but contained little not already released in the U.S.

Leonov told his audience that despite spinning at the end of his tether during the walk in space, he suffered no disorientation. He said smooth movements were required to exit from and enter the airlock of *Voskhod II*. He encountered minor difficulty in re-entering the ship. Like his American counterpart, Edward White, who made a later (and longer) walk in space from *Gemini 4*, Leonov said he returned to the spaceship "very unwillingly."

- **Hard landing**—*Voskhod II* commander Belyayev described the "very difficult circumstances" under which the Soviet ship landed. He brought the craft back to Earth under manual control when a component of its automatic landing system, which is controlled from the ground, failed. Films of the landing site show that the ship descended in a dense grove of trees in a snow-covered area far from civilization.

Belyayev said use of a retro-rocket soft-landing system, following parachute deployment, brought the vehicle's touchdown speed to almost zero. To reach their rescue helicopter, which was unable to land nearby, Belyayev and Leonov made their departure from the landing site on skis.

- **LIL problems**—A Lunar International Laboratory symposium held during the Congress took up the problems of establishing LIL, but shied away from the questions of who was to do it and how it was to be financed.

A paper presented for NASA's William Henderson and Boeing's G. L. Mitcham emphasized that one of the most important needs of LIL will be an adequate Earth-based data analysis system to interpret, catalogue and disseminate the flood of information from the Moon.

Georges Jobert of France called attention to the critical instrumentation requirements resulting from the vast range of temperature on the lunar surface. He said the most important parameter to be measured on the Moon is the origin of its internal heat.

LIL session chairman K. Y. Kondratiev of the Soviet Union emphasized the benefits of meteorological study of the Earth from the Moon, which has a view of the entire globe, and achieved something of a first when he used photographs taken by U.S. *Nimbus* and *TIROS* satellites to demonstrate the value of meteorological photography from above the atmosphere.

- **Ramjet gains**—AFSC's Dr. Goeth-

Attendance Record Set At International Meet

ATHENS—The XVIth Congress of the International Astronautical Federation drew some 1,500 scientists and engineers, making it the largest held to date.

Opening the Congress in an ancient amphitheater on the Acropolis, King Constantine told the delegates:

"You will permit me to say that it is particularly appropriate that this Congress should be held in this country which, after all, produced the world's first astronaut. I will not weary you with the circumstances in which Icarus took off from Crete, and I must admit that his flight ended somewhat disastrously; he obviously did not give sufficient attention to the physical problems of re-entry nor to the effects of solar energy on his unconventional propulsion system."

Next year's Congress will be held in Madrid.

ert told a session on unconventional propulsion that calculations based on estimated design data for Scramjet indicate that at speeds of Mach 10, supersonic burning ramjets offer specific fuel impulses approximately five times greater than those of the best chemical rockets.

At Mach 15, the specific impulse is about four times better and extrapolations indicate that at M20 and above, improvements of a factor of two or three are possible.

He pointed out that one advantage of supersonic ramjets is that area changes of inlet and exhaust for adaptation to various flight Mach numbers are much smaller than in subsonic ramjets since the sensitive flow region near Mach 1 is avoided.

Goethert noted that it is even possible to design supersonic ramjets for a wide supersonic and hypersonic range with fixed geometry—if some penalties in engine efficiency are accepted.

He acknowledged, however, the difficulty of stable combustion in supersonic flow, which has prevented development of such an engine in the past.

It also is necessary that chemical reaction occur in an extremely short time in order to hold the combustor within practical lengths. A chemical reaction time of hundredths of a second would mean a combustor length of 100 ft. at Mach 10.

"This indicates clearly the necessity of having the chemical reaction occur within a fraction of a millisecond before practical application of the supersonic ramjet technology is possible," he said.

Noting, that, with a hydrogen-air mixture, ignition delay is a function of the temperature and pressure of the gas mixture, Goethert pointed out that the gas mixture will not ignite when temperatures are below 700°R. At higher temperatures, ignition of such a mixture occurs rapidly, requiring at a static temperature of 3,500°R only 10^{-6} sec.

"Assuming for instance, that a supersonic burning ramjet would be designed such that the inlet temperature to the combustor would be 2,200°R, the ignition delay would be approximately 10^{-5} sec.," he reported.

"At such conditions, and at a flow velocity of 10,000 ft./sec. in the combustor (M 10), no more than 0.1-ft. length would be required for initiation of the chemical reaction. Adding the same length for completing the reaction, it is apparent that even at such readily attainable temperature levels, the combustor length required from the viewpoint of chemical reaction is quite small."

The AFSC scientist pointed out, furthermore, that these conditions improve rapidly when the temperature is raised to 3,000°R, "which is well within the region of present-day technology."

He noted that auto ignition conditions are easily achieved in the combustor but acknowledged that bringing the hydrogen molecules and oxygen molecules in proper contact is one of the prime difficulties in supersonic combustor design.

"It will frequently be unavoidable to arrange a set of fuel-injection struts in the air flow," he admitted, noting that these are detrimental in terms of flow losses and that design of the fuel injection system therefore is critical to success of Scramjet.

He also pointed out that Scramjet is very sensitive to aerodynamic flow at high Mach numbers.

"At Mach number 20, for example," he said, "the exhaust velocities are no more than approximately 3% larger than the free-flight velocity. It is obvious that at such high Mach numbers, a few percent of velocity reduction due to flow losses might nullify the entire net thrust, and even a net drag instead of a thrust might be produced."

He then added design of efficient inlets and nozzles and flow passages for air through the combustor to the list of critical items for Scramjet.

"Based on these considerations," Goethert told the group, "the chemical rocket can be expected to retain the operational region in the extreme high hypersonic Mach number range close to orbital speeds." The cross-over point, he said, will depend on success in design of high aerodynamic efficiency for Scramjet's internal flow.

Despite such difficulties, and the critical problems of material selection and structural design, Goethert believes a practical Scramjet design is within reach.

"Recent progress in supersonic combustion and ramjet technology has indicated that a major extension of the operational range of air-breathing propulsion systems is feasible," he declared.

- **Microwave concept**—Schad of Raytheon told the session that the new availability of large amounts of microwave power is what makes it possible to consider microwave booster rockets.

He pointed out that during the last five years, power available from single S-band tubes has risen from 15kw in 1959 to over 400 kw in 1964. He said new tube concepts and designs now available make it possible to predict power levels in the millions of kilowatts range within the next several years. He noted that an advanced design study of a 1,000-megawatt generator operating at X-band already has been carried out.

The microwave concept calls for transmission of power from the ground to the flying vehicle, thereby substantially lowering launch weight.

Schad also pointed out that under the concept, propellant performance is not limited by chemical bond energies, with specific impulses of 500 to 2,000 seconds appearing feasible. This would enable reduction of *Saturn I* gross weight at lift-off from 550 to 120 metric tons.

As presented, the microwave rocket would receive its power from a microwave generator that would convert power from a primary power generator to a very-high-frequency current.

This would be fed to an antenna that would radiate it in a narrow beam to a receiving antenna on the rocket. This would focus the radiated power into a reservoir where it would heat a propellant such as hydrogen, which then would be exhausted through a rocket nozzle to provide thrust. ■

RFP Issued for Manned Apollo Device

PROPOSALS ARE DUE at NASA's Electronics Research Center on Sept. 30 for development of an instrument to measure aerosol particles in the *Apollo* Command Module during the fourth *Saturn IB/Apollo* flight (SA-204), the first scheduled manned flight in the program.

The space agency's request for proposals on the experiment—designated T-3—calls for a six-month development program leading to a flight-qualified instrument. Work is to begin on Oct. 4 and be completed by April 1, 1966.

The development program, to be covered by a cost-plus-fixed-fee contract, calls for design; fabrication of two prototypes; preparation of reliability program, quality assurance, reliability prediction and estimation, failure mode effect and environmental qualification plans; fabrication of a flight-qualified analyzer, performance of environmental qualification testing and fabrication of two flight models.

Completely self-contained and hand-held, the instrument will be used by astronauts for measurements of space cabin atmosphere beginning soon after orbit is achieved and continuing at four-hour intervals throughout the 14-day mission.

Specifications include maximum weight of five pounds, total operating time of three hours, operation in the 5-psia oxygen space cabin atmosphere, and sampling rate of 1 cu. ft./hr.

Technical Countdown

MATERIALS

Polyaryoxysilanes Developed for Space

Scientists at Battelle Memorial Institute are developing methods for preparing engineering evaluation amounts of a new plastic polymer—polyaryoxysilane. The family consists of silicon atoms, oxygen atoms and thermally stable aromatic rings. The hybrid chain structures show promise for high temperature applications in thermal control coatings, rubbers, laminates, films, molding compounds and adhesives. Several polyaryoxysilane-coated steel panels withstood a temperature of 1,000°F for 8 hours without loss of adhesion. They have good stability to ultraviolet light and bonds with steel have demonstrated tensile shear strengths up to 4,000 psi. The Battelle work is under the direction of Dr. William R. Dunnavant. NASA's effort with the material is under J. E. Curry and J. D. Byrd at the Marshall Space Flight Center.

SPACE MEDICINE

Soviet Fruit Fly Studies Yield More Females

The latest edition of the Soviet publication "Problems of Space Biology" contains results of experiments with Drosophila (fruit flies) carried out by Nikolayev and Popovich in August, 1962, and Bykovsky in 1963. Males and females were brought together some 57 hours after launching, and normal offspring resulted. However, the occurrence among the progeny of considerably more females than males was attributed to low temperatures and more rigid nutritive media than usual.

Douglas Develops Computer Model for Man

Douglas Aircraft Co. scientists have developed a digital computer simulation of the thermal properties of the human body, which takes into account the servo-mechanisms that maintain constant skin and internal body temperatures, such as perspiration, metabolism, and vasomotor action. The mathematical model is one-dimensional and created for use in digital computer simulation of manned space flight. In this respect, it can portray the overall effects of the environment, on body temperature, heating, control of temperature, and the effect of the man on the environment.

Experiment to Check Radiation Theories

A radiation experiment for the *OV1-2* satellite will check a theoretical computer program to calculate radiation exposure that has been developed by Northrop Space Laboratories. The experiment, initiated by the Aerospace Medical Research Laboratory at Wright Patterson AFB, Ohio, takes the shape of a flight experiment sub-satellite (FESS) and also is developed by Northrop. It will be orbited at an inclination of 35 degrees, with a perigee of 236 miles and apogee of 1,836 miles. A 6-month lifetime, in which over 100 million pieces of data could be returned, is hoped for.

PROPULSION

UTC to Quench/Restart Large Solid Rockets

The feasibility of stopping and restarting large solid rockets will be studied by United Technology Center under an $800,000 contract from The Air Force Rocket Propulsion Lab at Edwards AFB, Calif. The program will use high-pressure water injection and includes static firings of motors containing from 10 to 1,200 lbs. of propellant. If the technique works with the smaller units, UTC will move up to a 120-in.-diameter motor weighing about 40 tons.

ELECTRONICS

Rocket Exhaust Plus MHD Equals Electricity

The exhaust from a conventional solid rocket fired through a magnetic field produced 1.5 million watts of power for a 1-second test at Hercules Powder Co.'s Bacchus, Utah, plant. The firm's Magnetohydrodynamics Research Group seeded the propellant with alkali metals to increase the conductivity of the 6,000-fps gases. The gas channel was a 5 x 8 x 60-in.-long tube with graphite electrodes. The 4-ton magnet had a field strength of 28,000 gauss. The power density obtained was 100 million watts per cubic meter and total yield was 1.5 million joules. Hercules experts say a reasonable scale-up to a channel length of 120 in. could yield a power level of 300 million watts, consuming about 250 lbs. of fuel per second with the time duration variable from milliseconds to several minutes. Commercial applications of the technique include use as power sources for gas wind tunnels, particle accelerators, X-ray machines, sonic transducers, shock tubes, high-field-strength magnets and standby power sources.

Cryoelectric Associative Memory Practical

The use of integrated-circuit photo-resistive technology shows promise of the early realization of an operational cryoelectric associative memory. Texas Instruments hopes to have a 250,000-bit unit operational by this fall.

Re-entry Heat to Generate Power

Sandia Laboratories, Albuquerque, N.M., reports development of a missile nose cone design permitting conversion of previously unused re-entry heat into electrical power without additional weight. The forward portion of the nose cone is separated from the rear section with an insulating material, but connected with an internal rod and load resistor, forming a plasma diode. On re-entry, the surface of the front portion emits a stream of electrons that flow through the plasma to the rear of the vehicle, which, because of its lower temperature and larger surface area, collects electrons and become negatively charged, current then flowing through the internal road and load resistor. Up to 30 amps per sq. in. of emitter surface has been obtained in tests of small models in Sandia's plasma jet facility. Tests also indicate such a generator incorporated into a 3-ft.-diam. re-entry vehicle would produce up to 1,000 watts of power without adding any weight to the vehicle.

Apollo I & I Ship Nears Completion

The first of NASA's three *Apollo* Insertion/Injection ships, the USS Vanguard, will be delivered on schedule to the Navy after marine structural modification by General Dynamics Electric Boat Div. The vessel, equipped with the new Unified S-Band system, will be operational by June 1966 and used to train personnel for the USS Redstone and Mercury. Delivery date to the Navy is Feb. 28, 1966, and the formal dedication will be in Boston in May.

Aerobee 350 Heralded as Scientific Workhorse

by William S. Beller

GODDARD Space Flight Center is pushing the *Aerobee 350* sounding rocket toward operational status in order to get second- and third-generation upper-altitude data as well as a test bed for satellite experiments and a training tool for scientists.

With much of the first-generation work already performed in the altitudes from about 50 mi. to 100 mi., a more sophisticated rocket is needed. In pointing this out, James Kupperian, chief of Goddard's Astrophysics Branch, said the new *Aerobee* "will let us move ahead 10 years in our scientific rocket program."

The predecessor *Aerobee*, the *Aerobee 150*, a workhorse researchers have launched all over the free world and which recently passed its 550th successful flight, is becoming obsolete for certain types of scientific work.

"Specifically in astronomy," said Kupperian, "we've reached the point where our experiments are compromised by the *150's* limited performance and weight-carrying ability." He noted that this was anticipated five to six years ago and has led to the design of the *350* rocket and its attitude-control packages.

The *Aerobee 150* is nevertheless far from dying. "Although we expect a gradual changeover from the *150* to the *350*," said John H. Lane, *Aerobee 350* project manager for Goddard, "still we foresee the *150* carrying various types of experiments for many years to come."

- **Doubled performance**—The *Aerobee 350* shows more than twice the performance of the *150:* for heavy payloads, the factor tends toward 2.5, showing the most significant advantage; for lighter payloads, the factor approaches 2.0.

The *Aerobee 350* launched from Wallops Island will carry a payload of 150 lbs. to 290 mi. altitude; or 500 lbs. to 210 mi. If the launching takes place at White Sands, N.M., which is at 4,000 ft., the rocket will put out 15-20 mi. more altitude performance for the same payload weight. An *Aerobee 350* launch tower is to be built at White Sands.

There are several advantages to having the pad at White Sands in addition to increased rocket performance: payload recovery takes place over land, which is a far less expensive recovery than over water; does not involve the payload in a salt-water environment; and does not rely on a boat, useless in bad weather and uncomfortable in good.

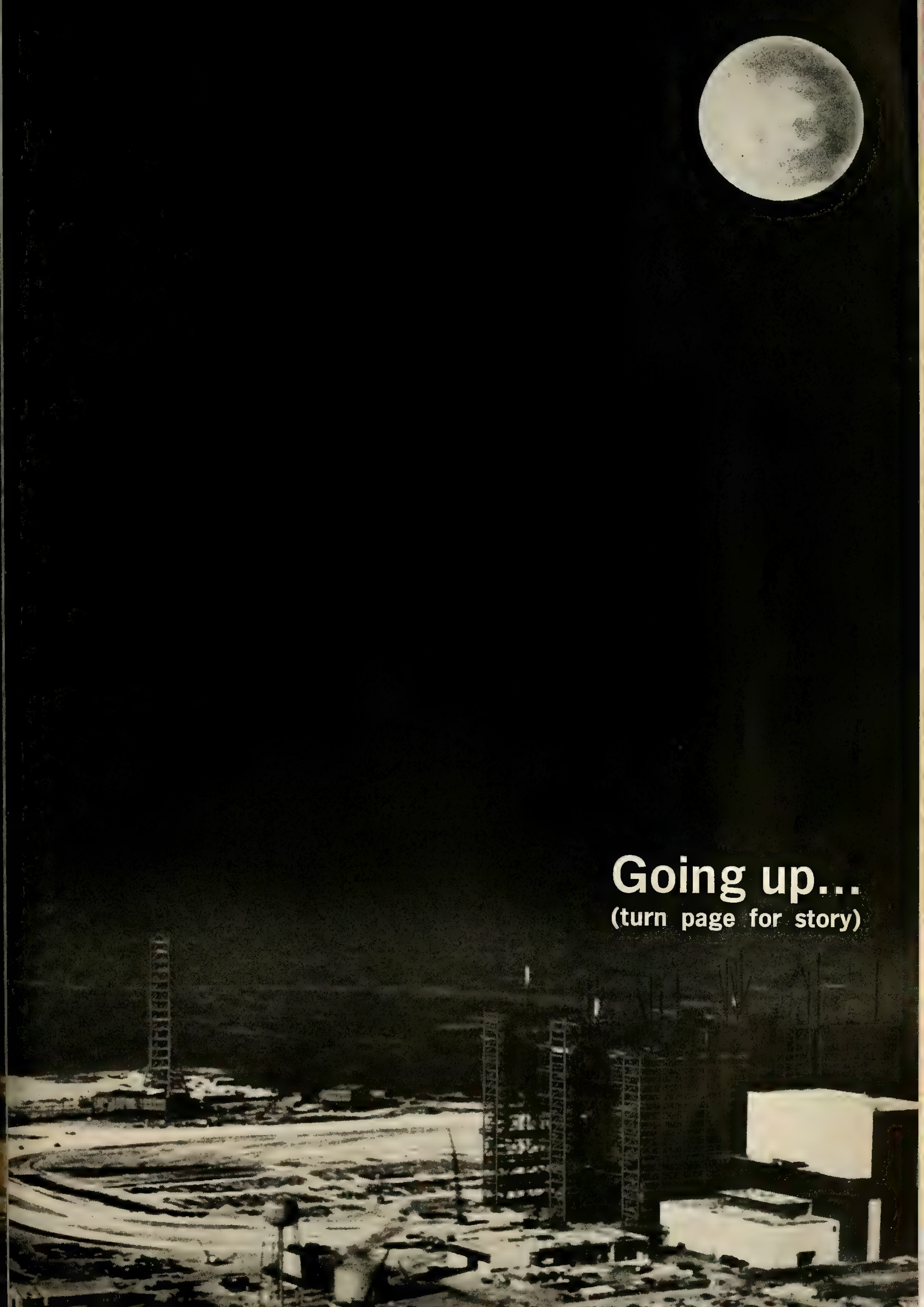
The *Aerobee 150*, a three-finned rocket, carries 150 lbs. to 150 mi.; for most applications of the rocket, 300 lbs. to 90 mi. These launch figures are for White Sands. The *Aerobee 150A*, a four-finned version usually launched from Wallops, has slightly less performance.

All of the *Aerobees* are developed by Space-General Corp., El Monte, Calif., under NASA contract.

- **Flight test results**—The first flight test of the *350* took place June 18 when the rocket carried 367 lbs. of performance test instruments to an altitude of about 235 stat. mi. and impacted in the Atlantic Ocean about 160 mi. from the launch site. More than 10 minutes of telemetered data were received, verifying that the *350* will be able to gather data at altitude for twice as long as the *150* for a capacity payload.

The new rocket is 52 ft. long, 22 in. in diameter and weighs more than 3.5 tons. This diameter is seven inches greater than the *150's*, which recommends it so highly to experimenters. The extra volume and length of the *350* payload quarters "are essential for astronomy," according to Kupperian. Unlike electronics circuitry, optical instruments are not easily miniaturized: they must have sufficient area to collect light, and larger areas are needed where more accurate measurements are wanted. The 15-in. diameter of the *150* is just about the minimum needed for the *Aerobee* attitude-control system.

Other possible rocket subsystems: a large telescope experimental package, ejection mechanisms, parachute recovery, telemetry, and film recovery package. These systems cannot all be combined on a single *150* flight, desirable as it is, but have to await the *350*.



Going up...
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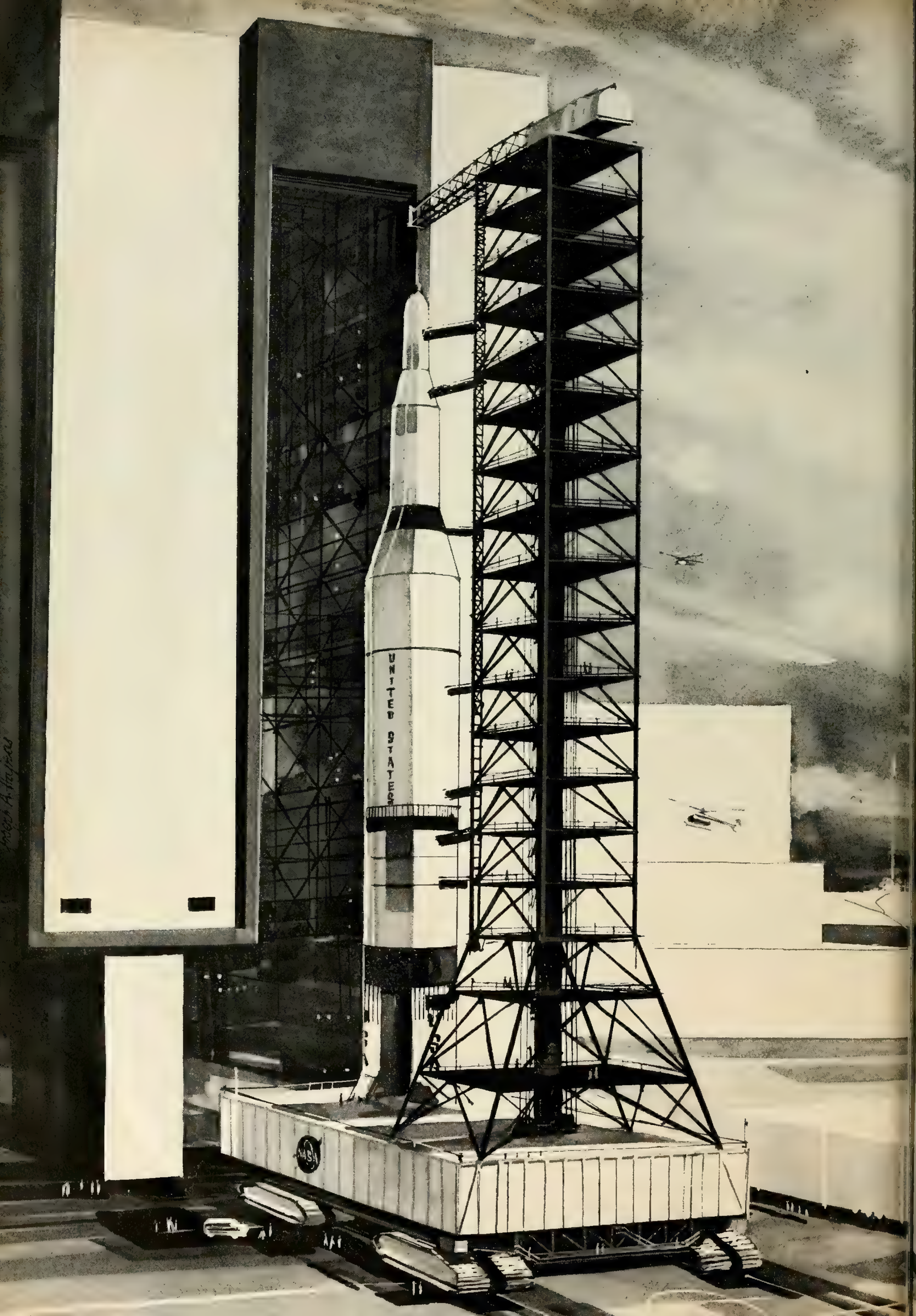

UNITED STATES
NASA

For the manned moon shot: the free world's largest launch complex.

The size of new facilities, now under construction at the National Aeronautics and Space Administration's Launch Complex 39, Merritt Island, Florida, surpasses any structures or machines previously used for rocket launches in the United States. The Apollo 3-man space craft and the Saturn V rocket will be assembled in the world's largest structure with a volume of 129 million cubic feet—one and one-half times as large as the Pentagon. Here an immense Mobile Launcher mounted on a steel platform half as big as a football field will hold the 263-foot-high Saturn V in place. When the assembly is completed, a Crawler Transporter will carry the tower and the Saturn V to the launch pad three miles away.

The Vehicle Assembly Building is so large that the 45-story New York Hilton hotel would fit into one doorway. For the structural framework, designers used A36 Steel, a basic grade to meet strength requirements. It is economical, and goes up fast enough to keep pace with changes and tight erection deadlines. Coupled with sound design, the A36 framework can support heavy loads and provide stability under hurricane winds up to 125 mph at the thirty-foot level and 195 mph at the roof level—526 feet high.

In April, 1965, American Bridge Division of U. S. Steel bolted the last structural member in place. This structure required 57,000 tons of steel, fabricated in plants throughout the country and shipped to Tampa, Florida, where it was unloaded, sandblasted, painted and hauled by truck to the site at Merritt Island. This demonstrates a real production and scheduling capability.

Mobile Launcher. This is a gigantic tower 380 feet high fabricated from A36 Steel and mounted on a half-acre, two-story steel base. The entire Saturn V Rocket, including the payload, will be launched from this platform. Eight steel umbilical arms, varying from 35 to 45 feet in length, will swing out like cantilever bridges and will provide access for personnel, and support for electric power and communication lines, air lines and propellant lines. The arms will be made of field-weldable USS "T-1" type A Steel tubing. "T-1" Steel's high yield strength of 100,000 psi (permitting a reduction of thickness) helps to keep tower weight to a minimum. Of equal importance, "T-1" type A Steel also will maintain the required strength even under the high temperature created by the rocket motor blasts as the space vehicle "lifts off" for the moon.

Crawler Transporter. This mammoth unit will move under the tower's platform base and pick up the mobile launcher and Saturn V Apollo vehicle and move them to the launch pad 3 miles away. Each transporter is bigger than a baseball infield and is 20 feet high with leveling jacks retracted. It will carry a load of over 6,500 tons on eight crawler tracks. USS COR-TEN High Strength Steel is used where it counts—in the chassis—because its strength up to 4" thick enabled a lighter design to be used for the forces involved.

USS capability in related Apollo/Saturn V projects.

Mississippi Test Facility. To meet NASA's requirements for the storage of liquid oxygen, liquid nitrogen and liquid hydrogen, U. S. Steel supplied USS 18-8S type 304 stainless steel plates. These liquids do not attack stainless steel. No harmful compounds form to clog valves and pipes. Along with this cleanliness, stainless steel has excellent toughness at temperatures as low as —452°F.

Saturn V Test Stand. For the dual test stand where the static firing of the first stage of the Saturn V will take place, U. S. Steel supplied steel H piles capable of supporting dead and live assembly loads in addition to withstanding operating loads when the rocket engines generate 7.5 million pounds of thrust.

New Design in Lox Installation. The use of USS 9% Nickel Steel in a liquid oxygen installation serving the Mississippi Test Facility made it possible to make substantial reductions in the cost per square foot of construction. In addition, the availability of rolled alloy steel structurals eliminates the cost of fabricating them. Only U. S. Steel makes quenched and tempered alloy steel structural shapes.

Lunar Excursion Module. For the lunar excursion module which will simulate lunar landings, the use of USS TRI-TEN Steel made it possible to minimize the bulk and weight of the key structural parts. To meet other rigid requirements took 15 different types of steel.

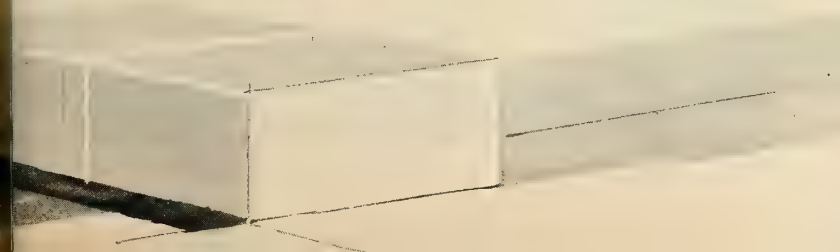
U. S. Steel not only had the capacity to produce, fabricate, and erect much of the steel used in Launch Complex 39 and related projects, but also has a group of technical personnel that is experienced in application problems. These capabilities are a major reason why construction advanced on schedule. For more information on our complete family of steels for construction, write United States Steel, Room 8353, 525 William Penn Place, Pittsburgh, Pa. 15230. *USS, "T-1," COR-TEN and TRI-TEN are registered trademarks.*

USS United States Steel: where the big idea is innovation

Front cover photo: A36 Steel framework of the Vehicle Assembly Building of Launch Complex 39 where moon rockets will be put together. Size when completed: high bay—518 x 442 ft. x 526 ft. high; low bay—442 x 275 x 211 ft. high. Doors 456 ft. high.

Steel This mark tells you a product is made of steel.

Design and construction supervision: Canaveral District, U. S. Army Corps of Engineers.
Design team, URSAM, was organized specifically to design the VAB and support facilities. It is a joint venture of engineers consisting of the offices of Max O. Urbahn, planning and architectural; Roberts and Schaefer Co., structural; Seelye Stevenson Value & Knect, mechanical, electrical, civil; and Moran, Proctor, Meuser & Rutledge, foundation engineering. William D. Alexander is URSAM Project Manager. Anton Tedesko, in charge of structural engineering for the VAB, is Vice President of Roberts and Schaefer Co. Prime Contractor: Morrison-Knudsen Company, Inc., Perini Corporation and Paul Hardeman, Inc., a joint venture. Fabricator & Erector of VAB framework: American Bridge Division, U. S. Steel.



The parachute recovery of the payload package is extremely important. Goddard has been using this technique with the *Aerobees* for the past two and a half years. Before that time it was considered an extra fillip to capture the payload. "Now if we don't do it, we're hurt," said Kupperian. The instruments put into the rockets are costly, perhaps reaching as high as $500,000 in the *Aerobee 350*. This is several times the cost of the rocket and its attitude-control system.

Any budget would suffer if recovery were not made; and where the astrophyics experimental group is small, as at Goddard, and has not the time nor manpower to build new instruments for lost flights, the penalty of no recovery is onerous.

● **Propulsion**—The *Aerobee 350* is sustained by four clustered *Aerobee 150* liquid engines, each developing a sea-level thrust of 4,100 lbs. and burning for about 52 sec. The booster stage uses a solid propellant *Nike* M-5 motor, which has a thrust level of 52,000 lbs. Sustainer and booster stages fire simultaneously, with the *Nike* burning out and separating about 3.2 sec. after launch.

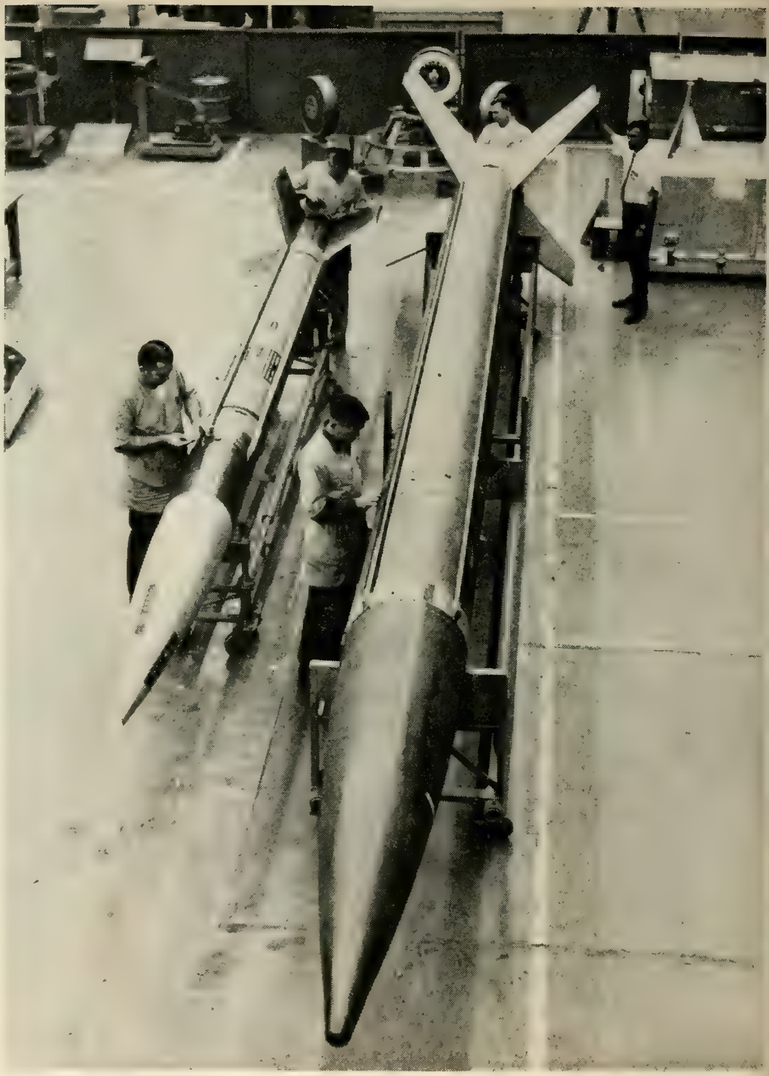
One advantage cited for the *Aerobees* and their liquid stage is the soft and relatively low-vibration ride they give. Launch g's could be held below 10, James R. Rowe, Space-General representative, told MISSILES AND ROCKETS, and can carry even the most delicate experiments. Launch reliability is estimated to be 95%.

Solids, on the other hand, are criticized for the "hard" ride they give and the small payload they can carry, even though to extreme altitudes. Goddard astrophysicists prefer a "gentle ride to modest altitudes," and are looking forward to putting a star tracker into the *Aerobee 350*.

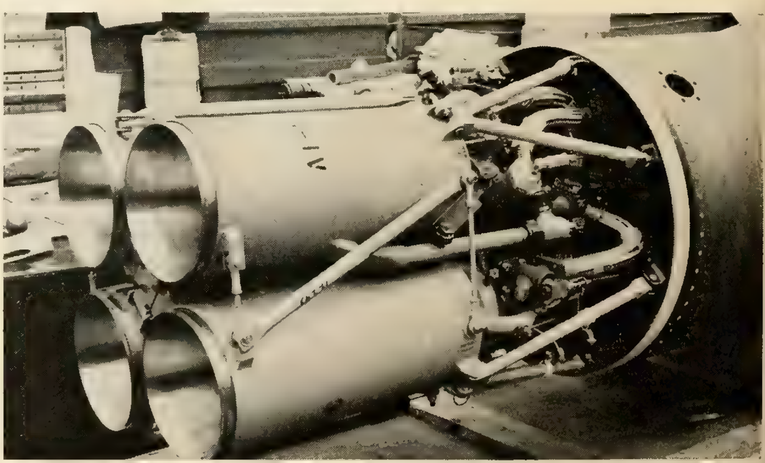
● **Guidance the key**—Space-General is updating the inertial attitude-control system (IACS) used on the *Aerobee 150's*. The electronics of the system will be transferred almost completely into the IACS for the *Aerobee 350*, unless some flight environmental factor prevents this. Such a factor was not apparent during the *Aerobee's* flight test. The pneumatic subsystem for the *Aerobee 350*, on the other hand, will have to be changed because of the difference in *Aerobee* sizes.

The present inertial system and the one under development, both using free gyros, will stabilize the *Aerobee* in roll, pitch and yaw. Pointing accuracy is ± 2 degrees, according to a Goddard project manager, because of error in launch angle, gyro drift during boost phase, and programming errors.

The error is reduced in a fine-attitude-control system (FACS) Space-



ABOVE: Aerobee 350, new liquid-fueled sounding rocket for modest altitudes, is checked out beside smaller Aerobee 150 standard operational sounding rocket. BELOW: Sustainer thrust for new Aerobee comes from cluster of four Aerobee 150 engines, each of which develops 4,100 lbs. sea-level thrust.



General is building. This concept involves adding a stellar or solar tracker to the inertial system. The inertial system orients the rocket within two degrees of a reference target. Then the tracker—with a field of view of ±3-4 degrees—takes over the control, eliminating the gyros. Logic networks within the tracker system actuate small jets, which establish the rocket within 30 arc seconds of the reference target. These jets have about 1/35th the thrust of the jets connected with the inertial system.

The breadboard for the *Aerobee 150* FACS is already completed and Goddard expects to launch the flight version in about a year, according to Frank Volpe, Goddard's project manager for the FACS. The FACS for the *Aerobee 350* program will be started within the next six months, and its first flight aboard a *350* is expected in September, 1967.

Meanwhile, Goddard itself has developed an interim attitude-control system called STRAP (Stellar Tracking Rocket Attitude Positioning) for the *Aerobee 150*. It first flew in May, will fly again in December, and six more STRAPs are on order. Designed and developed by William Russell, Goddard project manager for *Aerobee* control systems, and his associate, Henry Stintz, STRAP was conceived and operating within three months. The present *Aerobee 150* inertial system was used, and a star tracker added. The resulting system has a homing accuracy of 30 arc seconds, according to Russell.

The *Aerobee 350* will have no attitude control in its initial scientific flights, "hopefully beginning early next year," said Lane. He estimated a firing rate of two vehicles a year until the White Sands launch tower is built. At that time, the launch rate is expected to increase. Besides developing the launch complex at White Sands, the *Aerobee* project office is also developing payload housings and recovery systems for the new *Aerobee*.

- **Scientific advantages**—The *Aerobee 350* will let experimenters through their instruments look at five different targets in the sky, in sequence. For example, the instruments may first point at the Crab Nebula, a minute later at a planet, and so on. Normally the rocket would not be programmed for that many targets, but it is within the control system's capability.

Specific scientific experiments called out by Kupperian for the *Aerobee 350* include airglow, and X-ray, stellar and nebular astronomy. The instruments used here could presage those included on later satellite flights. Where Goddard is able, "we try our (satellite) experiments on rockets first," said Kupperian. Life tests, of course, cannot be simulated in this fashion, but operations and theory can. "We ask, for instance, can X-ray sources be picked up by an appropriate sensor on a space platform?"

As a result of data from rocket work Goddard is now programming ultraviolet and X-ray experiments in the *Orbiting Astronomical Observatory*. The experiments would not have been included so quickly in a satellite were it not for the rocket experience.

In similar fashion, Kupperian sees the *Aerobee 350* providing test beds for new experiments and scientific concepts that will find their way into satellites five or 10 years from now. He also pointed out that experimenters working with rockets are more aggressive scientifically because they are not faced with the high cost of a satellite.

Enlarging on his statement that the *Aerobee 350* is the rocket for the next decade for astronomy at modest altitudes—more than 100 mi.—and for certain geophysics work between 50 and 100 mi., Kupperian named fundamental questions still needing answers. Work has to be done in plotting high-altitude winds, airglow phenomenon, and in getting temperature versus time plots in the D-layer.

He suggests an examination of the influence on the upper atmosphere of the solar flux in the far ultraviolet and X-ray parts of the spectrum. The Sun does not change much in the near ultraviolet, visible or infrared; the change is less than one per cent. But in the far ultraviolet and X-ray bands, the change is by a factor of two or by many thousands during a solar cycle. This brings about vast changes in the solar flux. Kupperian suggests that changes in Earth weather with the solar cycle involve these radiations. We should consequently study the altitudes where much of this variable solar flux is absorbed.

Researchers using sounding rockets sometimes find themselves explaining why they are not using satellites. Unfortunately, the glamour of satellite research has put rocket probes in an inferior position in terms of financial support and development of advanced equipment.

Yet spectacular results have come from rocket research: the first ultraviolet spectra of Mars and Venus, which Goddard scientists will publish shortly; observation of the lunar eclipse of the Crab Nebula, by Herbert Friedman, Naval Research Laboratory; and British work on solar observations. The *Aerobee 350* may be the tool the rocket experimenters need to challenge scientific satellites for a bigger share of the space research budget. ■

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Undersea Rubber Under Scrutiny

New Goodyear department charged with broad responsibility, including sound transmission, erosion coatings, mining

by John F. Judge

Akron, Ohio.—The application of rubber and its technology to sound transmission requirements in anti-submarine warfare and oceanographic programs will be the primary concern of a new department in the Aviation Products Div. of the Goodyear Tire and Rubber Co.

The newly created Marine Products Dept. will also explore and develop other product areas such as anti-foulant and erosion coatings, surface and underwater storage containers, shelters and protective clothing for underwater operations and undersea mining and exploration equipment.

P. E. Gaylard, manager of fuel cell and fabric products for the division, has been assigned responsibility for the new department. "This is a logical extension of several of our existing activitites," says division general manager E. M. Eickman, "moreover, it will permit us to participate in this new field with many of our present customers, notably the aviation and aerospace companies, which have already initiated programs in these areas."

The current emphasis on sound transmission applications is based on several properties of rubber—a specific gravity closely approximating that of water and a sound transmission characteristic about equal to that of sea water.

The specific structures under consideration are sonar domes and windows.

Goodyear is an example of a growing number of firms with a primary product line well within the general field of materials that is consolidating both its development programs and product areas to the potential oceanology market.

- **Black winding**—Goodyear's APD has several new techniques under study in applying rubber in its many forms to structures. One already in the production stage at a new facility in Rockmart, Ga., combines the techniques of applying liquid rubber by spray gun or brush and filament winding.

This "black winding" method results in containers with high pressure resistance because the strength member is a continuous filament. One possible application is in deep submergence buoys.

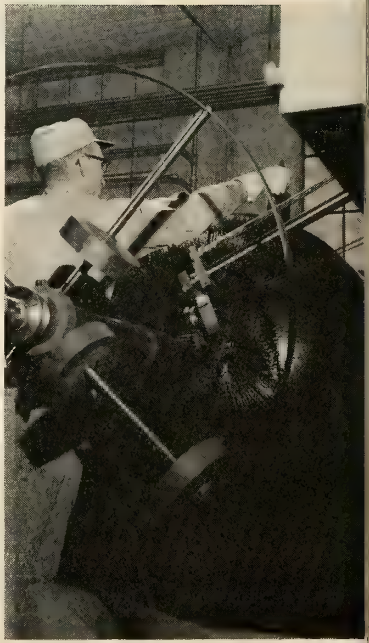
The Marine Products Dept. is currently concerned with the only energy form usable in the oceans—sound. Certain forms of rubber transmit sound waves in the same manner as water. Thus the rubber can be said to be "invisible" to sound waves.

This opens a wide application area in sonar domes, windows, buoys and housings of all types. In addition, Goodyear is developing several fabrication methods which are designed to remove the size limitation on rubber sonar housings.

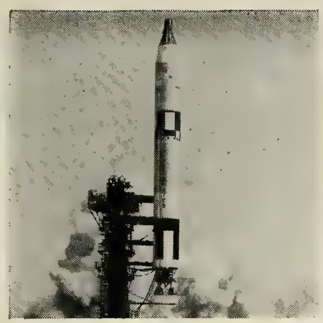
Current methods of manufacture follow the route of building such hydrodynamically shaped housings in sections and joining these to make an entire structure. The department has developed a process of forming even the largest housings as a single, seamless piece with a minimum of wall thickness.

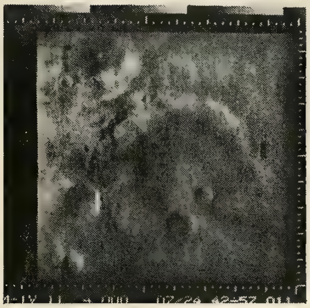
- **Better mousetraps**—The flexibility of rubber is leading to consideration of various mundane market areas such as ship and dock bumpers—both inflatable and otherwise. Rubber housings with mirror-like finishes are being designed for towed sonar arrays.

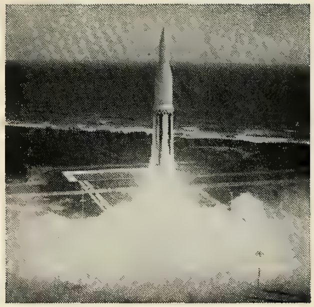
The Marine Products Dept., although new, can draw on many years of experience and data acquired by Goodyear as a whole in the ocean environment. In addition, the department is developing a whole family of antifoulant coatings. ■

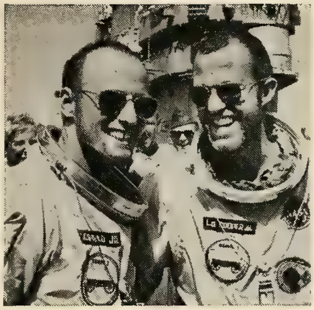


ABOVE RIGHT: One member of Goodyear's anti-foulant material family (left) survived 15 months in Biscayne Bay on three test slabs, while untreated panels (right) are heavily fouled. RIGHT: Goodyear's new method of applying liquid rubber by spraygun or brush and filament winding is illustrated. The Rockmart, Ga., facility can produce containers with a continuous-strength member in this manner.









what's next nasa?

MISSILES AND ROCKETS asked this probing question "What's Next NASA?" And on November 29, 1965, MISSILES AND ROCKETS will publish its Fifth Annual NASA Issue with answers to this question as well as an authoritative examination of the National Aeronautics and Space Administration's current and future projects and facilities.

After a year of spectacular achievement, including Astronaut White's record extravehicular space walk and Gemini 5's record 191 hours in space, NASA is looking ahead to its new space programs. Special emphasis is placed in this issue on the Apollo Extension Systems (AES) which have an estimated total cost of over $1 billion, and project Voyager, which will explore Mars, Venus and other planets.

This special issue will also explore NASA's plans for other new projects as the U.S. space program begins its swing away from the exploration of the Moon to the vaster and more challenging mission of probing the planets.

MISSILES AND ROCKETS provides the recognized and authoritative route to reach the men who will be making the research, design, engineering and procurement decisions in these new multibillion-dollar programs.

BONUS CIRCULATION: By request, the fifth annual NASA issue of MISSILES AND ROCKETS will provide 5,000 bonus circulation to the decision-makers in Government, the Atomic Energy Commission and the National Aeronautics and Space Administration.

Publication Date: November 29, 1965 Closing Date: November 15, 1965

American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington, D.C. 20005

missiles and rockets
THE WEEKLY OF ADVANCED TECHNOLOGY

Flexible Display System Gaining Users

Multicolor Nortronics 'Vigicon' accepts wide variety of inputs, presents data in many forms; applications include spacecraft mission analysis

by Charles D. LaFond

AN EXTREMELY versatile, multicolor projection display system, developed by the Nortronics Division of Northrop Corp., is rapidly finding application in diverse aerospace roles throughout the country.

Already in use by NASA, the Air Force and the Navy at several installations for each organization, another new system employing 24 projectors in three units is expected to be purchased soon by the Navy for installation at Roosevelt Roads, Puerto Rico. There it will be employed by the Atlantic Fleet Weapons Range during tactical weapons exercises.

Called Vigicon, the Nortronics overall system design uses all-solid-state circuitry and modular building blocks permitting great flexibility in fabrication of units for each different application.

A probable key to the rapid acceptance and use of Vigicon is the system's versatility in accepting presentation data from a variety of input sources, including many types of communication and data processing equipment. Of equal importance to broad application of the system are the many forms of data presentation available as options.

Each display configuration can employ several of each of three basic projector types:

—A reference projector providing static map, chart, or other background presentations from slides, automatically selected from storage magazines.

—A plotting projector that generates any form of line imagery (e.g., graphics, alphanumerics, and symbols).

—A spotting projector also provides dynamic traces as with the plotter, but its displays of instantaneous vector position are temporary presentations.

Systems according to developers, can be designed for theater or console display, front or rear projection.

● **Projector description**—Although each of the three projector types is similarly constructed, the plotting projector is the most sophisticated due to its functional nature.

A real-time plotting device, it projects images as they are generated. Employing four functional units—a light generator, slide-change mechanism, X and Y servomechanisms and the projection lens assembly, the device differs from the other projectors primarily in its X-Y plotting mechanism. These control movement of an opaque coated plate in two orthoginal directions. A third control tips the plate slightly into contact with a stylus or scriber. Thus, with an analog input from a processor providing data related to some dynamic situation, as a trace is made light is transmitted through the plate to the viewer screen.

Similarly, using a symbol generator as an input source, plot signals and voltages for plate movement can be ap-

LEFT: Vigicon demonstration display unit is capable of presenting command and control information in real time and in color. Both dynamic and static displays can be presented simultaneously on large and small screens. RIGHT: Spacecraft mission analysis display was built by Nortronics Div. of Northrop Corp. for IBM for installation at Goddard Space Flight Center.

plied to generate and display alphamerics and symbols.

Light source for the projector is an incandescent cylindrical lamp (300-1200 watts). Air cooled, the lamp also is provided with filters that reduce infrared radiation and thus help prevent heat damage to the projector slides. The remaining light passes through condensing lenses. On failure, a second lamp is moved into position within 0.5 second. (Failure is indicated externally so that the dead lamp can be manually replaced by the operator.)

For color, a six-filter turret can be provided about the lamp. Any color assignment, either manually or remotely controlled, is achieved in 1 second by rotating the turret until the desired color aperture is in the optical path.

A 40-slide magazine and handling mechanism is provided for projection of static graphics, also either manually or automatically operated. Slides are coated glass types mounted in stainless steel frames.

Low-distortion projection lenses complete the unit. Both focus and translation are adjustable.

The reference projector is identical in its configuration to the plotting projector, with the exception of the plotting mechanism, and stylus.

In the spotting projector, the slide-change mechanism and slide magazine are eliminated. Also, the stylus plate in the X-Y servo carriage is replaced by a slide already bearing some needed symbol which is to be moved over the display screen. For example, the symbol could be a ship that is moved by the X-Y servomechanism to show a continuously updated position.

If desired, a readout of coordinates of a symbol location can be obtained through the use of digital encoders, driven in parallel with the servo feedback potentiometers.

A single projector chassis weighs about 15 pounds and measures approximately 15.5 x 4 x 11 inches with the projectors mounted on 4-inch centers.

• **Current applications**—Operational displays so far developed and installed by Nortronics vary in configuration with each facility. The number of projectors employed for each unit vary with need, but the limit is about eight in a row (to prevent lateral distortion at the screen).

A large screen forward-projection system is used at the Navy's Anti-Submarine Warfare School at Norfolk, Va. In the ASW simulator there, a data processor provides inputs to the display system for depicting instantaneous ship's position of multiple tracks along with dynamic annotations. Three units are employed for presentation on three 10 x 10-ft. screens. A similar system will be installed at the San Diego ASW School for Pacific Fleet Task Force training.

Four systems employing folded optics and 30 x 30-in screen consoles will be built for use in an SH-2 ASW Helicopter Crew Trainer facility for the Naval Training Device Center.

A recently developed Vigicon system using a 6 x 6-ft. screen has been installed as a part of the IBM computer complex at NASA's Goddard Space Flight Center, Md. Designed for use as a spacecraft mission analysis display, it will be used initially for *Gemini* and *Apollo* trajectories or orbital plots and will be operated in real-time. Predicted or planned orbit versus actual orbit and predicted impact point will also be displayed.

Another NASA system, used for the Manned Spacecraft Terminal Landing System, has been installed in an air transportable mobile van at the Manned Spacecraft Center in Houston.

Other recent Vigicon systems include one to be delivered in October for the Navy's AUTEC Range in the Bahamas and one for use in the *X-15* experimental flight test program at Edwards AFB, Calif. ■

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Monkeys Unfazed By Radiation Exposure

by Heather M. David

SIX RHESUS MONKEYS exposed to a total radiation of 500 RAD's during a 10-day simulated space venture experienced no performance decrement. The radiation was administered at a rate of 2 RAD's per hour from an 80-curie gamma radiation source at the Los Alamos Scientific Laboratory.

Thirty-day physical examinations just conducted show that the animals are still in good health. An initial rise in white blood cell count was reported, but no physiological damage otherwise. Air Force scientists at the 6571st Aeromedical Research Laboratory at Holloman AFB, N.M., who supplied trained monkeys and technical assistance on the animal side of the project to Los Alamos researchers conducting the experiment, will run an identical study at Holloman without radiation starting Oct. 20 to determine whether any residual behavioral effects are present.

The initial experiment, which was concluded late in August, is part of an overall program on radiation effects at LASL. Chief investigator at LASL is Dr. John Spalding.

- **Experiment profile**—The month-long run started with a 10-day pre-exposure period at LASL to establish baseline averages. The monkeys were trained to perform switch-pulling and button-pressing tasks, which in a general way were designed to represent control operations of a spaceship. They followed a 6-hour work/6-hour rest schedule. However, no other attempt was made to simulate spaceflight conditions.

While the animals are reported to have exhibited slight nervousness during the experiment, they were able to equal their pre-test performances, with reaction times in some instances as good as 0.4 of a second.

During the experiment, the animals were placed in separate plastic modules with body movement restricted by plastic stocks or harnesses. They were housed in a concrete pillbox, which was exposed to a radiation source raised by remote control from an underground storage tomb at LASL.

Each day, a half-hour was taken to clean and service the facility and conduct physical examinations of the monkeys. During the rest preiod, biomedical monitoring and closed circuit television observation was accomplished by researchers housed in a control building about 100 yards away. Physical examinations also were carried out during a 10-day post-exposure period.

- **Second attempt**—The six rhesus monkeys are the second group of experimental animals to be used in this manner. Last winter, a group of macaque monkeys was brought to LASL and trained to perform psychomotor tests in the same way. However, these monkeys, which have more amply padded haunches than do the rhesus, circumvented the experiment entirely. With their cushioning, they felt no discomfort at all when prodded to perform by an electric shock apparatus.

The second species chosen had no such inherent insulation, and the experimenters were able to get the performance desired.

The follow-up study, which will be conducted at Holloman, will consist of the same 10-day pre-exposure profile, the 10-day test with performance tasks, and a 10-day post-exposure profile for comparison and to determine whether performance will continue to be as good.

While the exposure by no means simulates all the possible radiation doses that would be encountered in a space voyage, it provided information on what could happen with the amounts of gamma radiation that might occur during a solar flare. The Air Force Aerospace Medical Div. has other groups interested in research on whole body primate exposures to proton radiation from cyclotrons.

The experiment also did not attempt to delve into the question of how other spaceflight factors combined with radiation might affect a living creature. A number of studies, including some done by the Soviets, have suggested that acceleration or vibration, combined with radiation, produces a synergistic effect far more damaging than the supposed sum of the two. ■

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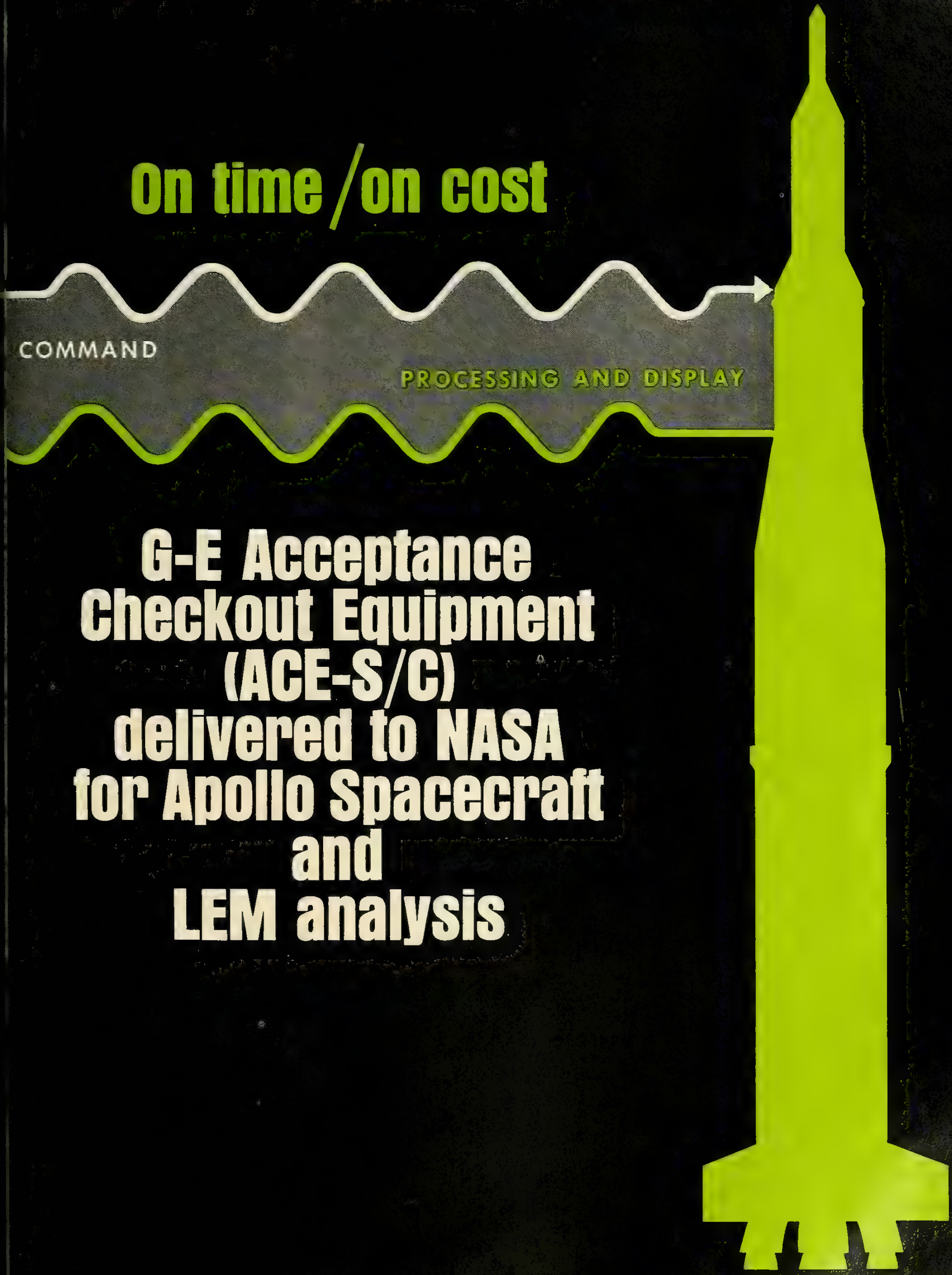

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Chemist—Fuel Cells
Applied electrode technology catalysis, or electrochemical technology.
Mathematician
PhD. Help make new, special purpose computers/programs.
Battery Technologists
Design, fabricate, test: High energy density batteries, electrodes, separators, cases, seals, components.

AIAA Meeting Focuses on Thermal Degradation

by Rex Pay

MONTEREY, CALIF.—Degradation of thermal control surfaces by space environments has been researched in theoretical and experimental studies, but the results have been ambiguous. What really happens in space may be best determined by recovering surfaces from operational spacecraft.

This may be attempted for the first time next year. Some 352 panels with 104 types of surface coatings are aboard the orbiting *Pegasus III*, and may be collected by *Gemini* astronauts.

If recovered, these panels will show the true effects of space vacuum, solar radiation, and charged particles—valuable information for designers of thermal control systems of future spacecraft. Problems of these systems were discussed at the three-day Thermophysics Specialist Conference held here by the American Institute of Aeronautics and Astronautics.

Thermal control has been accomplished with fair success in the past, but increases in size, lifetime, and complexity of space packages are creating new design demands. Perhaps the most stringent has been the request for a spring in a lunar-surface gravimeter to be stabilized to within 0.001°F, throughout lunar day and night. This limit has since been relaxed to 0.1°F.

Other new requirements are thermal control coatings for high-temperature nuclear environments, as on SNAP 10A, and thermal insulation for near-solar missions being studied by NASA's Ames Research Center.

An evening panel discussion outlined problems that have appeared in thermal control of operational spacecraft.

- **Overheating**—The *Ranger VI* television payload ran 20-40°F hotter than predicted, which led to design changes that yield nominal temperature levels in the rest of the series.

Parts of *Mariner II* heated to 75°F over design levels, which caused some concern as the spacecraft neared Venus. *Mariner IV* changed the pattern by running cool, an error that has been attributed to faulty solar-simulator calibration.

The S-IV stage attached to the *Pegasus* satellites is intended to act as a heat sink for thermal design purposes. It is running hotter than expected. Its surface ratio of absorptance to emittance is about twice that predicted, which may be due to blackening of the surface by the plumes of booster retro-rockets.

Outgassing of a *Delta* shroud during launch heating was thought to have contaminated the evaporated aluminum coating of *Explorer X's* magnetometer, causing it to fail due to overheating.

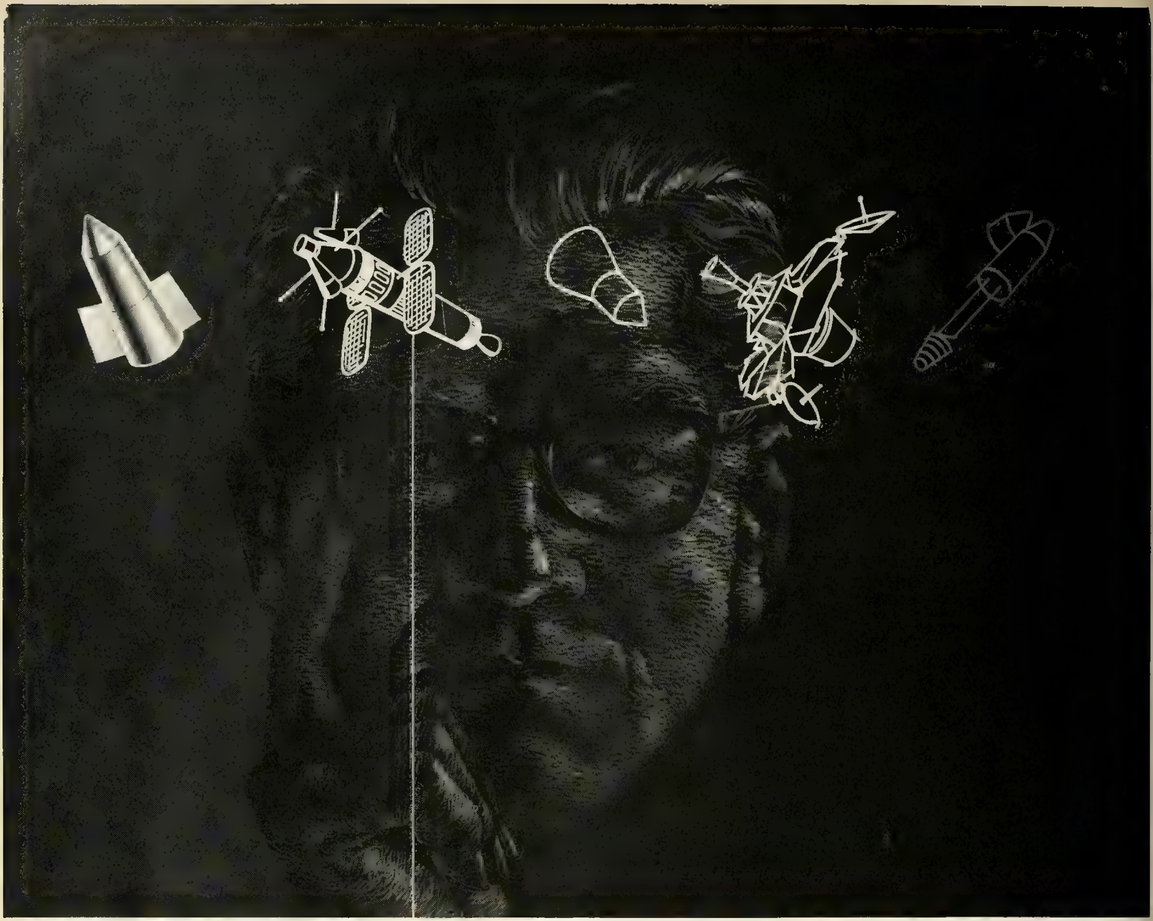
Flight temperatures on *Explorer XVII* showed a 25% deviation from the design ratio of absorptance to emittance. This led to discovery of an error in published data on emittances of aluminum and silicon monoxide films. Six satellites had previously used this data without showing trouble.

Unexplained temperature deviations from expected values have appeared in *IMP 1*, *IMP 2*, and *Ariel II*. Battery temperatures in *IMP 1* ran about 20°C above nominal and also showed an increase with time, suggesting coating degradation by the space environment. The coating is mainly black paint, with some evaporated aluminum and white paint areas.

- **Coatings**—The difficulties of predicting in-flight performance from laboratory tests of coatings have been underlined by experiments on the *Orbiting Solar Observatory 2* and on *Mariner IV*.

On *OSO-2*, a NASA-Ames experiment is being flown to provide "vitally needed information on the stability of coatings which might be used in the radiator system for the *Apollo* vehicle," said B. Douglas Pearson, Jr. Describing the results of the first 500-hours-equivalent Sun exposure, he said that the 12 surfaces flown showed that inorganic coatings were more stable than organic coatings.

Of the eight white coatings screened by North American's Space and Information Systems Division and qualified in simulator tests, an adhesive-backed film made up of titanium dioxide pig-



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ment in a silicone elastomer was the least stable. Most stable has been zinc oxide in potassium silicate.

Unfortunately, said Pearson, there are quite large discrepancies between flight and laboratory data. The most unstable coating in ground tests—zircon in potassium silicate—is among the more stable coatings in the flight tests. In contrast, zinc oxide in resin was among the more stable coatings in ground tests, but in flight proved to be one of the more unstable.

The *"Mariner"* philosophy, according to D.W. Lewis and T.O. Thostesen of Jet Propulsion Laboratory, is to avoid flying white paint in sunlight. They note that the value of this approach has been confirmed by the solar reflectance experiment on the *Mariner IV* spacecraft. Four sample surfaces are carried aboard the spacecraft to find the effects of solar radiation on materials with a wide range of absorptance-emittance ratios. One sample, an ARF-2 zinc-oxide potassium-silicate white paint, showed continuous degradation during flight—about 10 times as great as that found in laboratory UV tests used to select the sample.

Subsequent tests on the UV degradation of two specimens prepared at the same time as the flight samples have shown similar degradation rates in flight data. Lewis and Thostesen speculate that paint samples have properties that vary widely from batch to batch.

Degradation of thermal coatings under the combined effect of ultraviolet radiation and electron bombardment, using Stanford Research Institute's 1-MeV resonant transformer accelerator, suggests that satellites with extended lifetimes in trapped radiation belts are going to have thermal control problems.

- **Radiation effects**—Reporting findings of Lockheed Missiles & Space Company work carried out for the Air Force Space Systems Division, Ronald A. Breuch said the combination of the two forms of radiation produced a change in absorptance that was more than a simple additive effect in both Thermotrol and white Kemacryl. Mean electron energy was calculated as 0.8 MeV and total flux reached 6 x 10^{14} electrons per sq. cm. Some 436 equivalent Sun-hours of ultraviolet radiation were accumulated.

Additional tests carried out with 130-keV protons showed that a dosage threshold had to be reached before there was any degradation due to this radiation. Two optical solar reflector coatings did not damage in exposures of up to 5 x 10^{15} protons per sq. cm. Other materials such as white Kemacryl, Thermatrol, and Fuller gloss white started to degrade after doses of 10^{15} protons per sq. cm.

Breuch noted that synergistic effects of engineering importance had been found in low-energy electron (4-keV) and UV experiments carried out at Lockheed. This led him to recommend a study of the combined effects of proton and ultraviolet radiation.

A study by Boeing of the effects of solar protons on spacecraft and solar concentrator coatings showed that the dose absorbed on a typical Mars mission covered chemically brightened aluminum with blisters ranging in size up to 0.3 micron in diameter. Vapor-deposited aluminum became covered with similar blisters, as well as some up to 3.0 microns in diameter.

The main effect in both cases was to cause reflectance to drop off at wavelengths below 0.5 microns. Reduction of reflectance was small in the intense region of the solar spectrum for the doses used—0.61 x 10^{16} and 1.0 x 10^{16} protons per sq. cm., at 8.2 keV and 7.4 keV respectively.

In other tests in the Boeing solar-wind simulator, the solar absorptances of zinc oxide/potassium silicate and zinc oxide/ITV-602 (S-13) spacecraft coatings increased substantially with solar charged-particle radiation. ■

Lunar Orbiter Shroud Sent

FIRST flight test aerodynamic shroud for the Lunar Orbiter spacecraft has been delivered to NASA by The Boeing Co. The shroud will protect the spacecraft during early flight phases. The Lunar Orbiter. also built by Boeing, will photograph likely Apollo landing sites. The shroud is 13½ ft. long, 5½ ft. in diameter at the widest point, and weighs some 300 lbs.

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- **General flight mechanics engineering studies ranging from controllability at lift-off to payload injections.**
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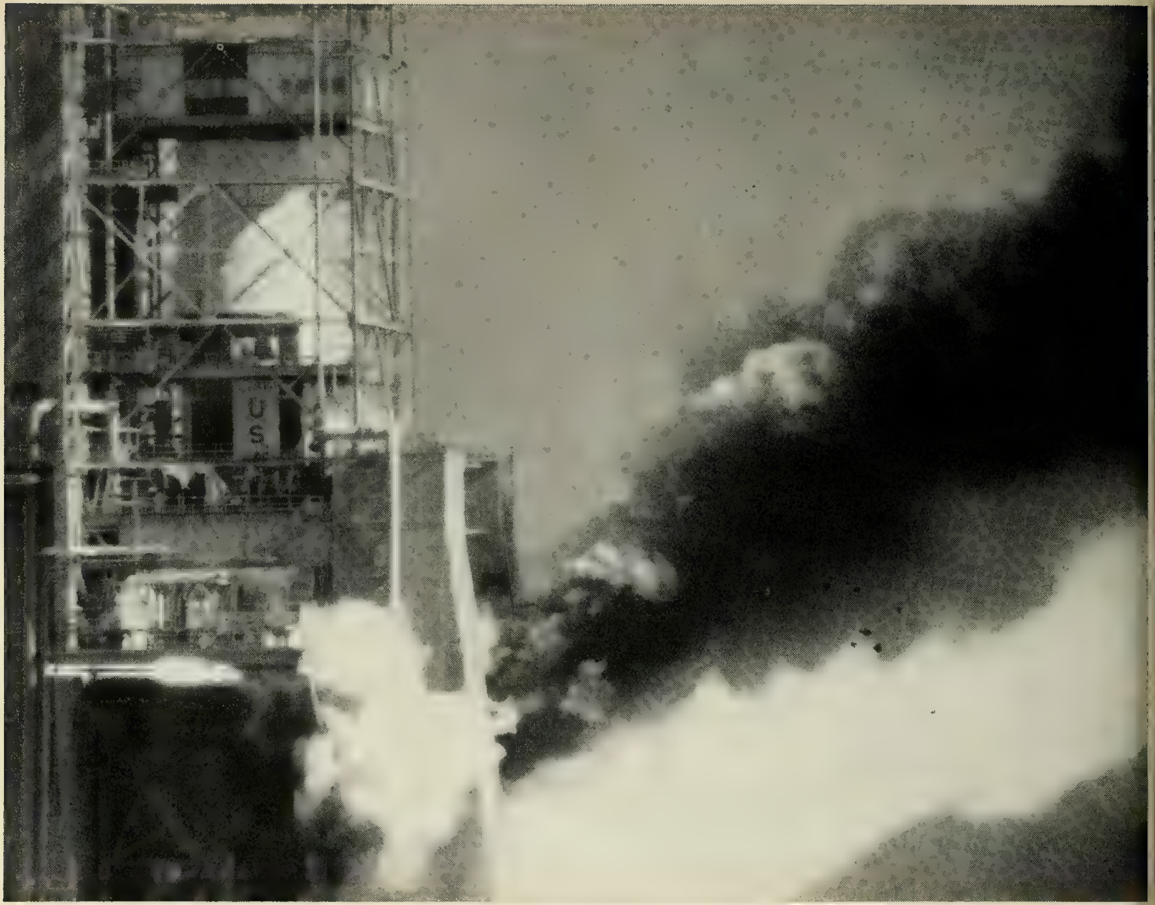

FIRST full-duration test firing of Saturn V's S-1C booster marked a major milestone on the way to America's first manned lunar landing. The test, conducted at NASA's Marshall Space Flight Center, generated the most force ever produced by a rocket—sufficient to create 160 million hp in flight. The Saturn V vehicle, tall as a 30-story building and weighing 3,000 tons, will launch American astronauts to the moon this decade. It will be able to put 100 tons into earth orbit, or propel several tons of instruments to Mars. Boeing holds a NASA contract to develop, build and test the S-1C booster.

Capability has many faces at Boeing

TWIN TURBINE Sea Knight, built by Boeing's Vertol Division, is U.S. Marine Corps assault transport helicopter. Tandem rotors fold in less than one minute for storage on carrier hangar decks.

SPACE BUBBLE, an inflatable balloon, suggested by U.S. Air Force and Boeing scientists, would protect astronauts while assembling platforms or repairing craft in space.

NEWEST jetliner, Boeing 737 Twinjet, will carry up to 115 passengers at 550 to 600 mph, over routes of 100 to 1100 miles. New 737 will offer more head room, more shoulder room than any other short-range jet. It has been ordered by Lufthansa, Pacific, United and Western.

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The Industry Week

New Activities

Corning Glass Works, Corning, N.Y., has formed a Fluidic Products Dept. to elevate the status of its fluid amplifier effort. Since it first entered the fluidics field in 1960, Corning has expanded its standard Fluidic product line to 15 units. The company also makes integrated fluid devices and systems to customer specifications. . . . *Radio Corp. of America has formed a new West Coast Div. of RCA Defense Electronic Products with headquarters in Van Nuys, Calif. The action incorporates in one management structure the functions of facilities at Van Nuys and West Los Angeles. The Van Nuys plant specializes in data processing and display devices; the West Los Angeles plant is the headquarters of RCA's Aviation Equipment Dept., which has responsibility for commercial airborne electronics equipment.* . . . Fairchild Camera and Instrument Corp. and International Business Machines Corp. have signed an agreement providing for the exchange of all patents on semiconductor electronic components. Included in the agreement is Fairchild's planar process for making transistors, diodes and integrated circuits from silicon. In exchange for the rights to the process, Fairchild is to receive an undisclosed amount of annual royalty from IBM. According to the *Wall Street Journal*, the agreement is a nonexclusive arrangement to run for 5 years. . . . *The first west coast chapter of the Marine Technology Society has been formed. Chairman of the organizing committee was E. P. Wheaton, vice president and general manager of Lockheed Missiles & Space Co. Among the objectives of the year-old organizations are: disseminating marine science and technical knowledge; promoting and aiding education of marine scientists, engineers and technicians; and advancing the development of tools to explore, study and exploit the oceans.*

Facility Expansions

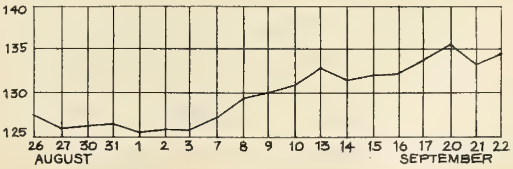
Atlantic Research Corp.'s Missile Systems Div. has broken ground in Costa Mesa, Calif., on a group of facilities that will total 126,000 sq. ft. and combine the division's operations now located in El Monte, Duarte and Monrovia, Calif. The expansion is expected to be complete by July. Part of the division, the Coast Coil Group, will remain at its present location in Los Angeles. . . . *The Boeing Co. has begun work on a new central fabrication plant at Auburn, Wash., 15 miles south of the company's Seattle complex. The plant is to support manufacturing operations at the company's Seattle-based divisions and will include plastic and metal-bonding equipment, heavy production machines, including skin and spar mills, duct and welding shops. First move into the plant is expected next January.* . . . Hewlett-Packard Co.'s Datamec Div., has announced plans to build a 60,000-sq.-ft. manufacturing plant in Mountain View, Calif. Construction of the $1-million plant is expected to begin in November and be completed next summer. Datamec, founded in 1961, makes computer magnetic tape units and other computer input-output equipment. It was acquired by Hewlett-Packard on July 1, 1965. . . . *Hughes Aircraft Co. has leased 67,000 sq. ft. of office space in a new building adjacent to Los Angeles International Airport. Occupants of the new space will include major portions of the Phoenix missile system program, some Advanced Projects Laboratories personnel and other Aeronautical Systems Div. personnel.* . . . The Navy is building a launching complex at Vandenberg AFB, Calif., in support of its *Bomarc* target program. The facility is expected to be ready for firings early in 1966. The modified *Bomarc A* missiles to be launched from the site will serve as targets for Navy and Air Force air-to-air and surface-to-air missiles.

International

Cossar Electronics Ltd., Harlow, Essex, England, has formed a Marine Div. with headquarters in London, to market marine products made by Cossar and other companies within the Raytheon Group. . . . *Adamas Carbide Corp. of Kenilworth, N.J., has made a 10-year licensing agreement with Sinterloy of Castellamonte, Turin, Italy, whereby Adamas' tungsten carbide tools, dies and wear parts will be manufactured in Italy by Sinterloy.* . . . Bell & Howell Co. has opened a 23,000-sq.-ft. engineering, manufacturing and administration building in Basingstoke, England. The building will house facilities of the Consolidated Electrodynamics Div. of Bell & Howell Ltd. The 1.8-acre site, located 40 miles from London, will accommodate two 11,000-sq.-ft. expansions, currently in the planning stage.

Missile/Space Stock Index

The Missile/Space Stock Index continued to set new records this month as the threat of conflict with Red China increased. It subsided somewhat last Tuesday, however, as the situation improved and chances of an Indian-Chinese border clash diminished. Rumors of the impending announcement of a contractor for the C5A cargo aircraft kept stock prices on Boeing, Douglas and Lockheed oscillating. Boeing jumped eight points in one week, with Douglas climbing five points the next, both setting new highs. Year highs were also set by many of the stocks in MISSILES AND ROCKETS' representative 19 companies.



100 = CLOSING PRICES OF 19 REPRESENTATIVE AEROSPACE FIRMS DEC. 31, 1964
STOCK PRICES FURNISHED BY MERRILL LYNCH, PIERCE, FENNER AND SMITH

contracts

AIR FORCE

$7,550,000—**Cessna Aircraft,** Wichita, Kan., for follow-on work on bomb racks, missile pylons and missile ejection racks for the Phantom jet.

$6,500,000—**The Boeing Co.,** Seattle, to develop a highly reliable, low-cost, solid-fuel upper rocket stage for placing small-to-medium-sized payloads into orbit. It will be called Burner II and placed atop a *Thor* standard launch vehicle.

$1,310,000—**Babcock Electronics Corp.,** Babcock Aerospace Div., Costa Mesa, Calif., for production of an electronic Miss-Distance Indicating System (BIDOPS) to measure the nearest approach distance of a missile to the target vehicle.

$1,000,000—**Hercules Powder Co.,** Baccus, Utah, for continued production of flight configuration motors for *Athena* boosters.

$800,000—**United Technology Center,** Sunnyvale, Calif., for a program to determine whether combustion of large solid rocket motors can be stopped and restarted.

$332,000—**TRW, Inc.,** Systems Group, Redondo Beach, Calif., for targeting and related support activities for RDT&E of the 494L system.

$244,000—**Space General Corp.,** El Monte, Calif., for research directed toward study of sounding rocket performance.

$150,000—**General Nucleonics Corp.,** Claremont, Calif., for experimental verification of the use of X-ray scattering for air molecules for sensing air density.

$121,925—**North American Aviation, Inc.,** Space and Information Systems Div., Downey, Calif., for measurement of unsteady aerodynamic pressures in transducers transonic flow and comparison with theory.

$118,404—**University of Dayton,** Research Institute, Dayton, Ohio, for processing, reduction and presentation of meteorological data.

$85,000—**Astrodata, Inc.,** Anaheim, Calif., for Doppler digitizing system.

$50,000—**Tyco Laboratories,** Waltham, Mass., for study of new materials of the nickel boride type for use as fuel cell anodes.

$49,870—**Beckman Instruments, Inc.,** Fullerton, Calif., for infrared leak detector applicable to universal fuel cells.

$45,000—**General Telephone & Electronics Corp.,** Sylvania Electric Products, Inc., New York City, to train personnel and to test and service *Minuteman* equipment at Hill AFB, Utah.

ARMY

$10,372,870—**Raytheon Co.,** Andover, Mass., several contracts for *Hawk* missile system repair parts and modification kits.

$7,175,356—**Radiation, Inc.,** Melbourne, Fla., for production of satellite communication terminals.

$1,142,000—**General Electric Co.,** Syracuse, N.Y., for continued production of *Nike-Hercules* missile radar.

NAVY

$14,702,000—**Westinghouse Electric Co.,** Baltimore, for continued work on Mark 48 torpedoes.

$10,740,000—**The Boeing Co.,** Morton, Pa., for continued work on UH-46A helicopters.

$3,800,000—**Laboratory For Electronics,** LFE Electronics Div., Boston, for production of AN/APN-141(V) radar altimeters.

$2,200,000—**International Telephone and Telegraph Corp.,** Federal Laboratories, Nutley, N.J., for additional ground/shipboard Tacan receiver-transmitter equipment and sonar training devices.

$533,231—**Philco Corp.,** Western Development Laboratories Div., Palo Alto, Calif., to develop an Operational Satellite Control System.

$266,298—**Granger Associates,** Palo Alto, Calif., for provision of a quantity of ionosphere sounders for the *Apollo* program.

$178,831—**Hughes Aircraft Co.,** Fullerton, Calif., for research on set based strategic systems in an arms control environment.

$149,100—**Walter-Darwin Teague Associates,** New York City, for quality assurance program for *Talos* missile.

$145,365—**Goodyear Aerospace Corp.,** Akron, Ohio, for addition to basic contract for unit cost control program for *Subroc.*

$67,317—**Bunker-Ramo Corp.,** Canoga Park, Calif., for buoy-mounted X-band radar transponders with directional receiving system.

$58,730—**Geoscience, Inc.,** Cambridge, Mass., for magneto-telluric studies of Earth resistivity.

$39,960—**Raff Analytic Study Associates, Inc.,** Silver Spring, Md., for study to derive better models of ASW performance by correlation and trend analysis of data from operational exercises.

$33,774—**General Dynamics/Electronics,** San Diego, Calif., for drone separation ranging system.

$29,735—**Dunlap and Associates, Inc.,** Darien, Conn., for research in design of a human factors program.

$25,386—**System Sciences Corp.,** Falls Church, Va., for research on Naval communications long-range requirements.

NASA

$1,500,000—**ITT Federal Electric Corp.,** Houston, to provide technical information and logistical support services for the Manned Spacecraft Center.

$1,382,687—**Industrial Engineering Co., Inc.,** Baltimore, for construction of Stadan engineering and real-time station and manned space flight network engineering training center.

$720,000—**Honeywell, Inc.,** Aeronautical Div., Minneapolis, Minn., for *Apollo* Command Module Block K stabilization and control system and for a system mockup test console.

$491,400—**General Dynamics/Electronics,** Rochester, N.Y., for diversity telemetry receivers.

$349,000—**Lockheed Missiles & Space Co.,** Sunnyvale, Calif., for study of liquid propellant behavior during periods of varying acceleration.

$268,000—**Radio Corp. of America,** Communications System Div., Camden, N.J., for a wideband TV recorder.

$190,000—**Cryonetics Corp.,** Burlington, Mass., for production of leak meters for use during missile launches.

$140,500—**Systems Engineering Laboratories,** Fort Lauderdale, Fla., for data conversion systems.

$108,000—**Northrop Corp.,** Norair Div., Hawthorne, Calif., for lifting body research vehicle.

$90,000—**Northwestern University,** Evanston, Ill., for design and development of ultraviolet stellar astronomy experiment.

$82,283—**Avco Corp.,** Research and Advanced Development Div., Wilmington, Mass., for study of 3-D fabrication of ablative materials.

$79,543—**Electro-Optical Systems, Inc.,** Pasadena, Calif., for meteorological experiements for manned Earth-orbiting missions.

$74,680—**University of Arizona,** Tucson, Ariz., for feasibility study of ultraviolet photographic survey of star fields via 6-in. *Apollo* camera.

$57,000—**Diecraft, Inc.,** Sparks, Md., for digital camera and monitor.

$54,372—**Northrop Corp.,** Norair Div., Hawthorne, Calif., for spares for *M-2/F-2* and *HL-1D* lifting body research.

$49,965—**Operations Research, Inc.,** Silver Spring, Md., for study of advanced ground station for post-1970.

$46,508—**Westinghouse Electric Corp.,** Defense and Space Center, Baltimore, for study on real-time telemetry data processor.

$29,000—**Martin-Marietta Corp.,** RIAS Div., Baltimore, for solid-state studies in ceramic alloys.

Motorola, Inc., Military Electronics Div., Scottsdale, Ariz., for development, fabrication and feasibility demonstration of a spacecraft-to-spacecraft Unified S-Band rendezvous and communication system. (Amount not disclosed.)

INDUSTRY

$1,200,000—**Potter Instrument Co., Inc.,** Plainview, N.Y., from **Sperry Rand Corp.,** Univac Div., St. Paul, Minn., for production of digital magnetic tape transports.

Wilmont Castle Co., Rochester, N.Y., from **Avco Corp.,** Research and Advanced Development Div., Wilmington, Mass., for study of methods of sterilizing a typical *Voyager* probe/lander of the type which might land on Mars in 1971. (Amount not disclosed.)

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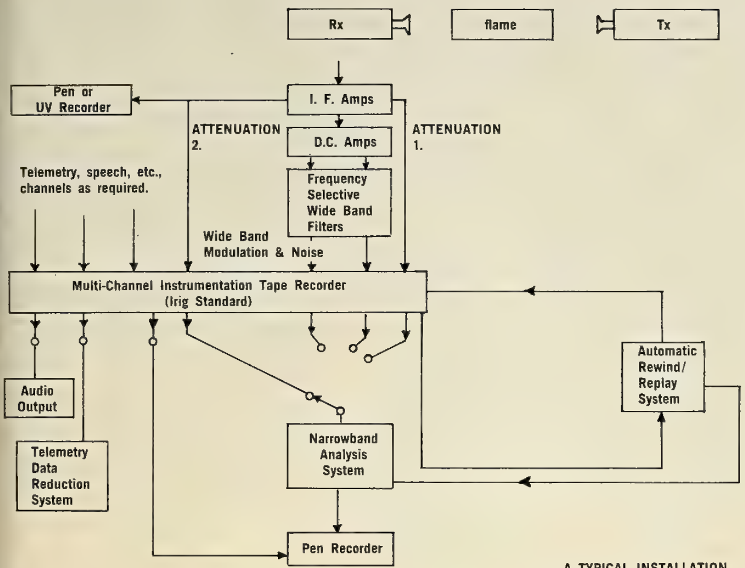
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A TYPICAL INSTALLATION

New Product of the Week: Rocket Motor Flame Analyzer

Automatic equipment for analyzing the effect of rocket motor flame on radar signals has been developed by James Scott (Electronic Engineering) Ltd.

The equipment consists of a transmit/receive system with facilities for determining attenuation of the appropriate signal frequencies by the flame, combined with a multi-channel high-speed recorder. It also incorporates an analyzer with a sensitivity capable of detecting low-order noise modulations induced by the flame.

According to the firm, radar signals transmitted between ground and a missile will in most cases pass through the rocket motor flame path. This will have the effect both of attenuating the signal and inducing spurious noise modulations. Characteristics of different types of motors will vary.

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Cryostat

A liquid hydrogen temperature cryostat for biaxial tensile testing has been designed by Hofman Laboratories.

The unit is rectangular in cross section to fit restricted dimensions of existing biaxial tensile test machines; the dewar accommodates an 18x18-in. cross-shaped test specimen. The double-walled device has four pull rod connections placed at 90-degree angles for biaxial tensile loads up to 120,000 lbs.

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—names in the news—

Eugene Franke: Joined DynaPlex Corp. as manager of RF engineering. He will be responsible for the development of a new product line of solid-state telemetering transmitters for aerospace and ground applications.

David R. Hull: Joined Electronic Industries Assn. as director of the association's Engineering Dept. He was formerly an executive with Raytheon Co., and two-term past president of the association.

Joseph W. Gurnow: Named manager of marketing for the Stratos Div. of Fairchild Hiller Corp.

Capt. Winfred E. Berg (USN-Ret.): Joined the National Aeronautics and Space Council as an aerospace assistant and member of the professional staff. He was formerly chief of research in the Office of Naval Research, and was senior program officer in the Navy's Project *Vanguard*.

Dr. Richard A. Mayer: Named a senior engineer at Operations Research, Inc. He will perform analyses of chemical and biological weapons systems.

E. St. P. Bellinger: Appointed assistant to the general manager of the Synthetics Dept. of Hercules Powder Co. **John M. Eagan** has been appointed director of operations, replacing Bellinger in the position.

Lawrence J. Stratton: Joined Arthur D. Little, Inc., industrial research and consulting firm. He was formerly manager of research and development for the Power Equipment Div. of Lear Siegler, Inc.

Robert W. Hoy: Appointed manager of Baldwin-Lima-Hamilton Corp. division, BLH Electronics-West.

Douglas N. Bean: Appointed director of manufacturing for the Digitronics Corp. He will direct company activities in manufacturing, purchasing, and facilities.

G. E. Bezar, A. V. Cline and P. F. Shepherd: Named to the board of directors of Strategic Industries Assn. Bezar is controller of U.S. Polymeric Chemicals, Inc.; Cline is a partner in Cline & Fast, Los Angeles public relations firm specializing in the aerospace field; Shepherd is vice president of James, Pond & Clark, Inc., manufacturer of Circle Seal non-leaking check valves.

Vaughn Williams: Appointed chief engineer of Rocket Power, Inc., a subsidiary of the Maremont Corp.

J. L. Taylor: Awarded the Commanders Cross of the Order of Merit by the Federal Republic of Germany in recognition of his leadership and contributions in establishing a German operations research capability in support of Germany's defense planning. He is director of Northrop Corp.'s Operations Research Development Program for free world nations.

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—when and where—

SEPTEMBER

Data Management Symposium, sponsored by Air Force and the Aerospace Industries Assn., Beverly Hilton Hotel, Los Angeles, Sept. 28-30.

Advanced Incentive Contracting, sponsored by National Defense Education Institute (NDEI), New York City, Sept. 28-30.

Sixth Annual Symposium on Physics and Nondestructive Testing, sponsored by Air Force Materials Laboratory, Sheraton-Dayton Hotel, Dayton, Ohio, Sept. 28-30.

Second International Congress on Experimental Mechanics, sponsored by Society for Experimental Stress Analysis, International Inn, Washington, D.C., Sept. 28-Oct. 1.

1965 Fall National Symposium of the Society for Information Display, Commodore Hotel, New York City, Sept. 29-30.

Twelfth National Vacuum Symposium, sponsored by American Vacuum Society, Statler-Hilton Hotel, New York City, Sept. 29-Oct. 1.

OCTOBER

First International Water Desalination Exposition and Symposium, sponsored by U. S. Department of State, Department of the Interior, and Atomic Industrial Forum, Inc., Sheraton-Park Hotel, Washington, D.C., Oct. 3-9.

20th Annual Instrument Society of America International Conference and Exhibit, Ambassador and Biltmore Hotels and Sports Arena, Los Angeles, Oct. 4-7.

Aeronautic and Space Engineering and Manufacturing Meeting, sponsored by Society of Automotive Engineers, Statler Hilton Hotel, Los Angeles, Oct. 4-8.

European Space Research Organization Meeting, Paris, Oct. 5-6.

Ultrasonics Conference and Exhibition, London, Oct. 5-6.

Eleventh National Aerospace Instrumentation Symposium, sponsored by Instrument Society of America, Ambassador Hotel, Los Angeles, Oct. 5-7.

Research and Development Cost Seminar, sponsored by NDEI, New York City, Oct. 5-7.

J. M. Burgers' 70th Anniversary Symposium on the Dynamics of Fluids and Plasmas, sponsored by Air Force Office of Scientific Research (AFOSR), University of Maryland, College Park, Oct. 6-8.

1965 Congress of the International Federation for Documentation, sponsored by AFOSR, Office of Naval Research, Army Research Office, National Science Foundation and Council on Library Resources, Washington, D.C., Oct. 7-16.

Pan American Congress of Electrical, Electronics and Mechanical Engineering, sponsored by Institute of Electrical and Electronics Engineers, American Society of Mechanical Engineering, Society of Automotive Engineers, Hotel Del Prado and Auditoria Nacional, Mexico City, Oct. 9-17.

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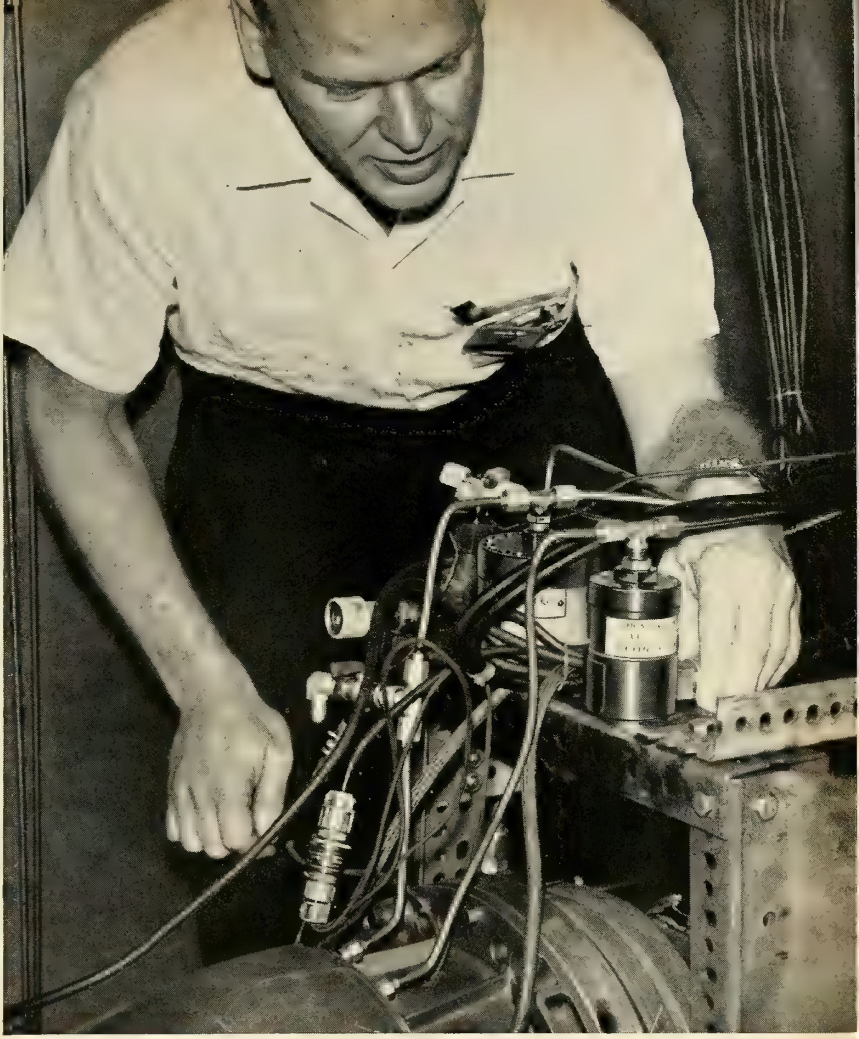

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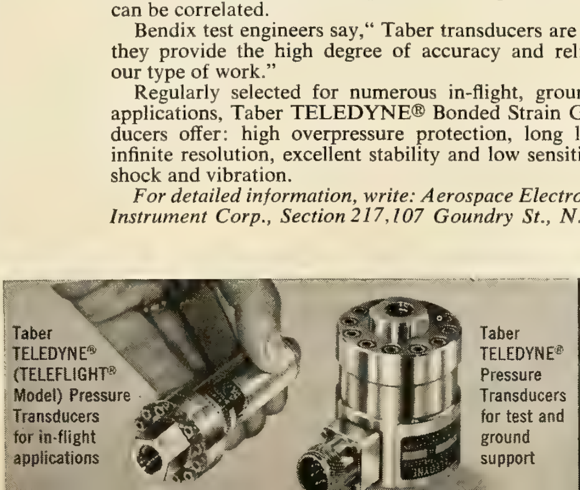

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The Aerospace Elephant

ANY THOROUGH ANALYSIS of the recent report on Aerospace Corp. by the Hardy subcommittee must start with the realization that Congress, the Air Force and the corporation itself are in total conflict about just what sort of creature Aerospace really is.

Members of the subcommittee see Aerospace Corp. as a totally captive organization, with a status not much different from that of Space Systems Div. or Ballistic Systems Div. Company officials regard it as a necessarily independent organization much like other aerospace firms, operating in a free-enterprise economy but with the major difference that its "profit" from Government contracts is spent for the public good rather than distributed to stockholders. The Air Force takes the position that whatever Aerospace is, it has done a good and much-needed job on programs vital to the nation's well-being.

There is something sadly reminiscent in this of the tale of the blind men trying to describe the elephant. There is an element of truth in what each of the participants says, but an intelligent grasp of the whole picture is lacking by all three.

A detailed reading of the final subcommittee report and of the 232-page account of the four days of hearings last May leaves the impression that each of the participants is talking about a different organization.

The Air Force contracting officer at Aerospace Corp. told of his attempts to negotiate the Aerospace fee on the basis of "need" in line with his directives from above, while Aerospace officials refused to accept this, insisting that fee should be based on "worth of task."

He testified that 200 times at meetings with Aerospace officials he asked them to reveal how they were spending fees and 200 times these requests were turned down. In a report to higher authority, he said: "The contractor refused to discuss any aspect of his financial management plans, his required amounts of working capital, the requirement for facilities that would not be provided by the facilities contract or any need for fee for business costs not acceptable under the contract."

With no sign of support from above, the contracting officer then attempted to set the fees by guesswork on presumed "need" while Aerospace continued to insist its request was on the basis of "worth of task." This impasse apparently was not resolved until the committee began its investigations.

The subcommittee disclosed that after Air Force Secretary Zuckert issued a policy statement declaring that not-for-profit organization fees were to be related to "need," not to "worth of task," Aerospace Corp. President Ivan Getting sent a memo to the company's board of trustees in which he called the Zuckert concept "in fundamental conflict with traditional basic American national economic ideas."

The committee probed with some wonderment into a situation in which items disallowed as reimbursable under the contract immediately disappeared into the "fee" category, there to be paid under the same contract.

Company officials, at the same time, were obviously disgruntled at an Air Force approach that would have given it such complete control as to usurp President Getting's job as head of the firm.

The committee itself has been caught up in the general confusion, and its claim of "needless expenditures of millions of dollars of public funds" is based largely on the belief that $40,000-a-year scientists and engineers can work just as well in a converted warehouse as in a modern office building. It also steadfastly refuses to accept Aerospace salaries and fringe benefits, which, for the most part, are not particularly out of line with those in the private sector of this industry with which it competes.

It is perhaps well, in all of this, to have on the record Gen. Bernard Schriever's reminder of the worth of Aerospace Corp. The head of Air Force Systems Command outlined for the committee some of the accomplishments of Aerospace. He listed increased *Atlas* reliability, *Titan III* program definition, anti-satellite studies and other achievements —including financial ones—of substantial value to the nation. He pointed out that in the case of one proposal, Aerospace work on costs made possible a saving of some $14.5 million; that its technical knowledge has made it possible for the Air Force to avoid false starts on several projects.

It is perhaps typical of the atmosphere surrounding the Aerospace hearings that the subcommittee chairman chided Gen. Schriever for introducing this into the record, noting that the committee was interested not in the concept, but in fiscal and management policy. The very first recommendation of the subcommittee, of course, was that the whole concept of Aerospace Corp. be reappraised.

WE BELIEVE, however, that the Hardy report quite rightly lays the blame for the Aerospace mess at the door of the Air Force. There obviously was a lack of management to enforce official Air Force policy. At the same time, there are many things to be said for what Aerospace believed that policy should be, rather than what it was. There also must be understanding for the Air Force concern to get the job done and clean up the management details later.

The investigation, the hearings and the report have been unpleasant, of necessity. But we strongly believe it all will prove exceedingly worthwhile if it forces Aerospace, Congress and the Air Force into agreement on just exactly what the Aerospace elephant is—and should be. As of now, there is no such agreement. This is the major finding of the Hardy subcommittee.

William J. Coughlin

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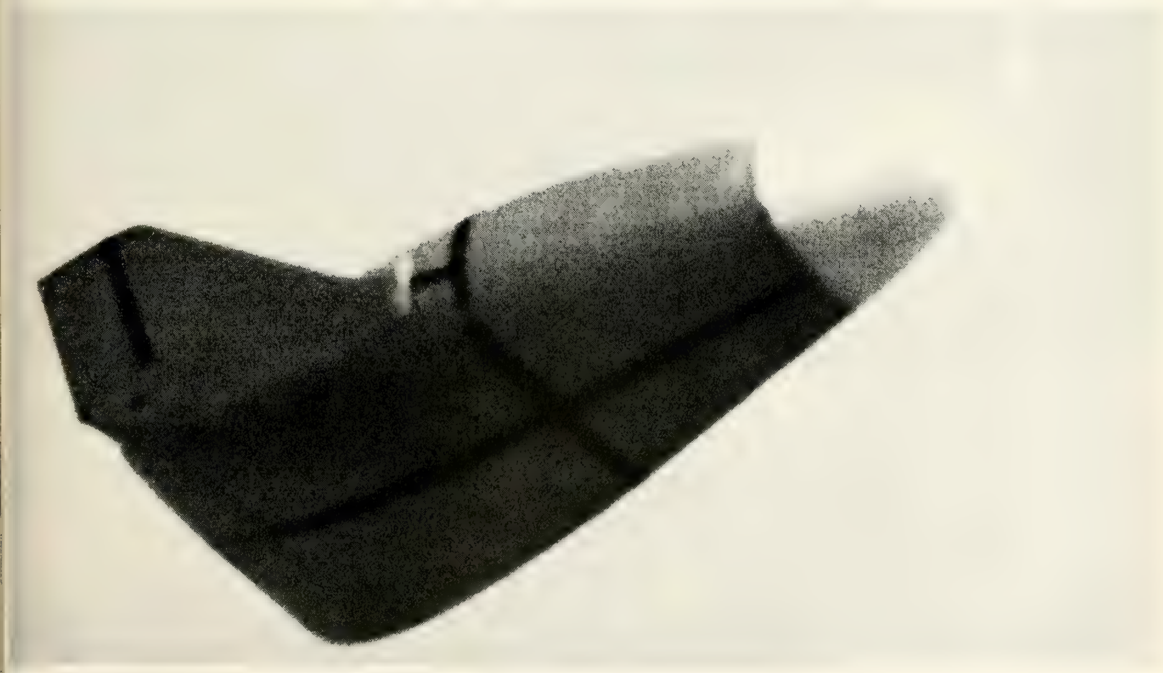

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OCTOBER 4, 1965

missiles and rockets

HE WEEKLY OF ADVANCED TECHNOLOGY

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GTA-6 Duration May Be Altered

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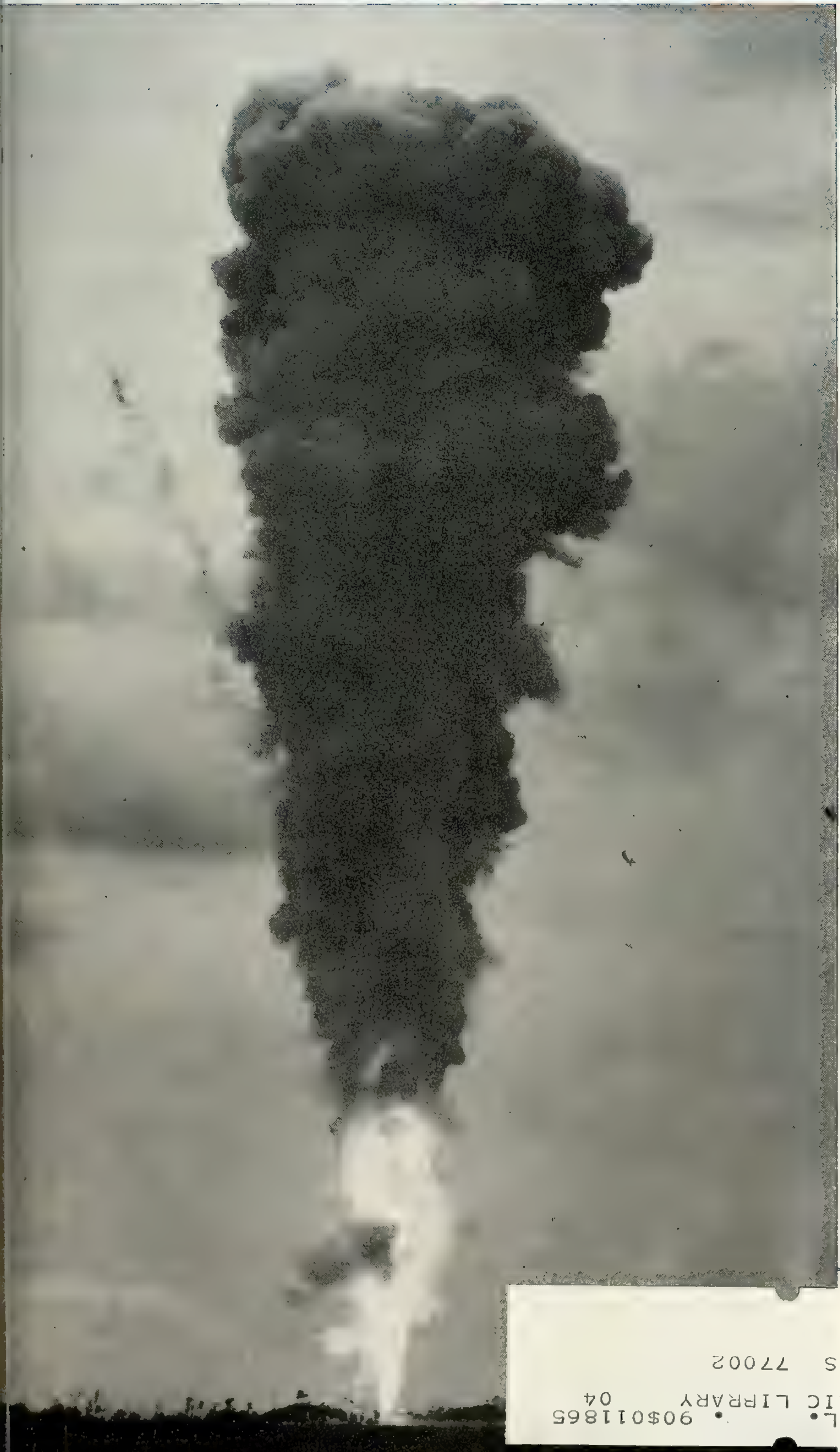

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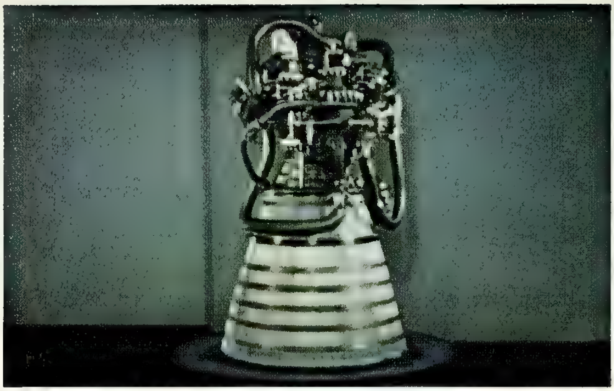
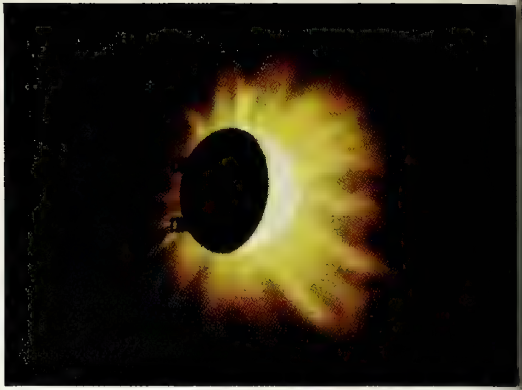
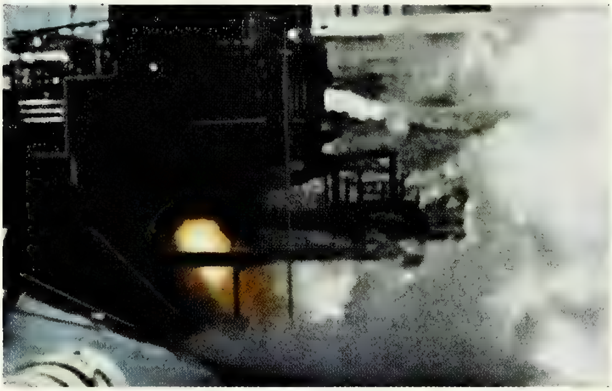


OCTOBER 1958: Design began on the RL10, first liquid hydrogen rocket engine.



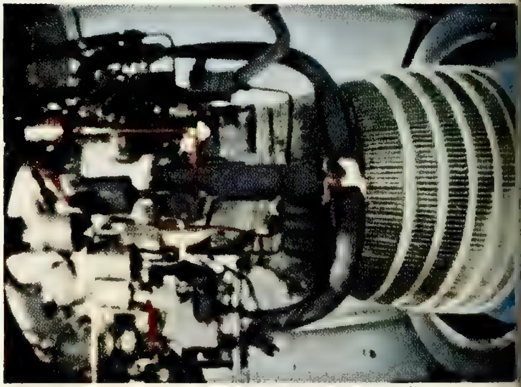
JULY 1959: First RL10 fired.



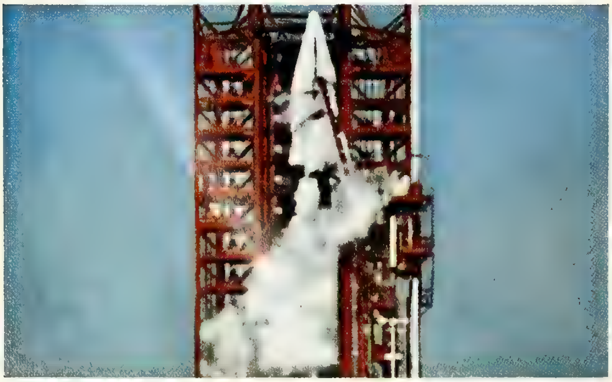
MARCH 1962: Static firing of first Centaur test vehicle, powered by two RL10s.

AUGUST 1962: Static firing of Saturn S-IV stage, powered by six RL10s.

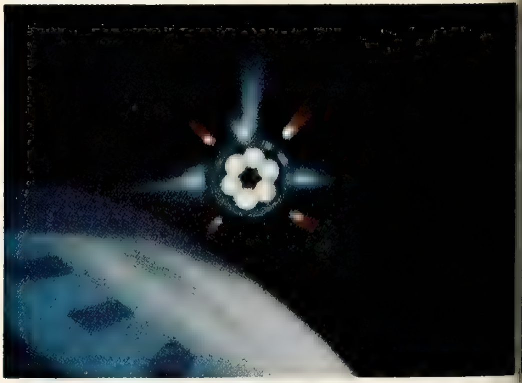
SEPTEMBER 1962: RL10 throttleability demonstrated.



JUNE 1963: RL10 instant stop-start capability demonstrated.



NOVEMBER 1963: RL10s power first Centaur vehicle in orbit.



JANUARY 1964: RL10s power first Saturn S-IV vehicle in orbit.

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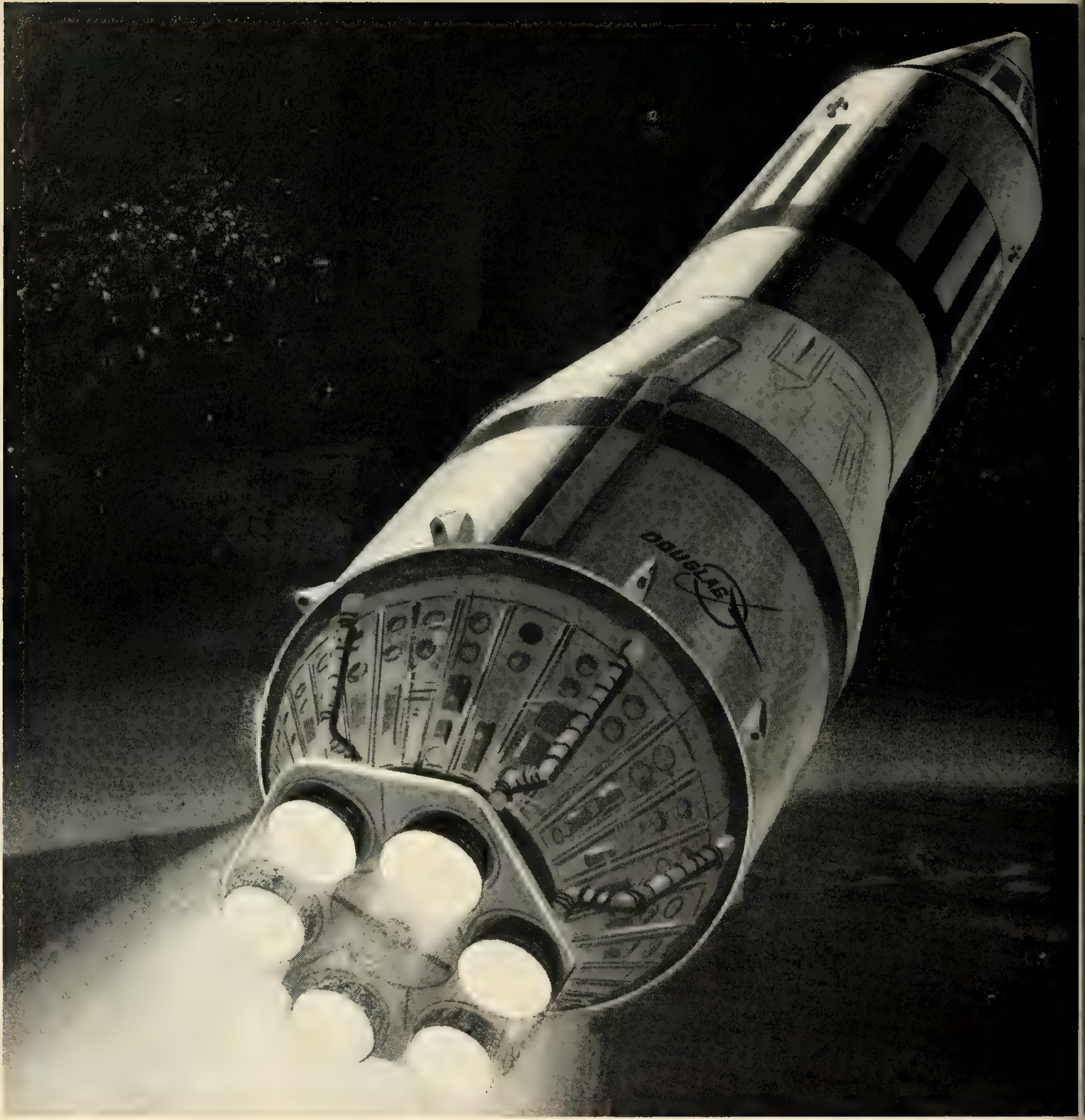

Six in a row for the NASA/Douglas S-IV Saturn rocket

The sixth straight shot for the Douglas S-IV upper stage of the Saturn I rocket marks an unprecedented 100% success for a major space program. And now the National Aeronautics and Space Administration's Saturn I-B rocket, with a Douglas S-IVB upper stage, is soon to begin flight testing.

At Douglas' huge research and industrial facility in Huntington Beach, California, the most advanced in the world, Saturn S-IVB stages are being built under the direction of NASA's Marshall Space Flight Center. One of these, as the third stage of the Saturn V rocket, will put Apollo in earth orbit and then moon orbit before 1970.

DOUGLAS

MISSILE & SPACE SYSTEMS DIVISION

missiles and rockets
THE WEEKLY OF ADVANCED TECHNOLOGY

Volume 17, Number 13 October 4, 1965

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THE COVER

Exhaust flame and smoke plume are shown seconds after Sept. 25 ignition of NASA/Aerojet 260-in.-dia. half-length solid motor. Igniter unit is seen at upper left, arching to its impact area. Two balloons at right center were used to loft sound instruments. See story, p. 18.

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letters

Ceramic Whiskers

To the Editor:

There were several incorrect statements on page 31 in the article, "Ceramic Whisker Output Boost Seen" (M/R, Aug. 23, p. 28).

1) In reference to the recent Air Force Materials Symposium, the statement that the symposium "was restricted to those holding contracts with the Air Force" is not true. The criteria for admission were that if the firm had a facility security clearance and the individual had a security clearance he could be admitted as a "potential contractor." Any DOD, NASA, AEC, etc., contract could have been the source of security clearances.

2) The statement that "the entire area of whisker-reinforced composites was totally ignored" is not true. Ceramic whisker composites were briefly discussed in the Non-metallic Composites Panel and were discussed at some length in the Metallic and Ceramic Composite Structures Panel.

3) The article states that the ceramic whisker area was ignored for "lack of proponents at a meeting scheduled only once every five or six years." There was in attendance a significant number of competent scientists and engineers in the area of ceramic whisker composite development. These included the industry Co-chairman of the Metallic and Ceramic Composite Structures Panel of the symposium. Several other Air Force and industry people, known to be competent in the area, entered into discussions in the area of ceramic whisker composites.

4) The meeting has been scheduled every three or four years, not five or six as stated in the article.

Lee R. Standifer
Colonel, USAF
Director
Air Force Materials Laboratory
Wright-Patterson AFB, Ohio

Aerospace Corp. and OV-2

To the Editor:

I read with interest your article ("Radiation-Monitoring Satellite Awaits *Titan III-C* Launching," M/R, Sept. 20, p. 15), concerning the *OV-2* satellites. I must inform you, however, that there are some serious errors and omissions regarding the organization which is responsible for the major scientific and technical design of these satellites. The original idea for transforming the unused *Arents* satellites, which were transferred to the Aerospace Corporation by the U.S. Air Force, into scientific research satellites was proposed by the Space Physics Laboratory of the Aerospace Corporation to the Air Force Office of Aerospace Research. In addition, about half of the experiments which you described in your article were designed, assembled and calibrated by the personnel in that same laboratory. Furthermore, a major part of the responsibility for the integration of the instruments and other technical details associated with the satellites were handled by those same personnel. The fact is that these *OV-2* research satellites would never have come into existence had it not been for the efforts of the Aerospace Corporation.

Dr. Stanley C. Freden
Space Physics Laboratory
Aerospace Corporation
El Segundo, Calif.

Lunar Dust

To the Editor:

The extremely thin atmosphere of Mars could hardly have caused appreciable wind erosion. Yet dust is there, as evidenced by telescopic sightings of numerous dust storms. This dust may be finely pulverized and lightweight, in order for the winds of the thin atmosphere to pick it up. The big question: How deep is it?

By reasonable assumption, almost the same erosion causes (meteors, cosmic particles, etc.) exist on our Moon, which so closely resembles Mars in all respects. Even the freezing and thawing of frost probably existed on the Moon at one time. Our Moon does not have sufficient atmosphere to generate dust storms, but, from comparison with Mars, we can reasonably assume that the finely pulverized, perhaps even fluffy, dust is there. Now, three recent and separate scientific studies (one in Russia), using different methods, have each arrived at an average depth of about 20 feet for the lunar "fluffy stuff." Looks like maybe floats for the landing module, in spite of earlier theories to the contrary?

T. M. Morse
Santa Maria, Calif.

Mr. Smithson's Observatory

To the Editor:

If I may be excused for a bit of professional nit-picking, we are not the "Smithsonian Astrophysical *Laboratory*" (M/R, Aug. 16, p. 18), nor are we "Harvard's Smithsonian Astrophysical Observatory" (M/R, Aug. 30, p. 26).

The Smithsonian Astrophysical Observatory has just celebrated its 75th anniversary as a bureau of the Smithsonian Institution, Washington, D.C. For the last 10 of those 75 years we have made Cambridge, Mass., our headquarters. Here we have shared facilities, resources, and research projects with the Harvard College Observatory. While this somewhat unique relationship is confusing at times, we are definitely an "Observatory" and most certainly part of Mr. Smithson's Establishment.

By the way, regardless of what you call us, we appreciate the fine news coverage of our projects and personnel.

James C. Cornell, Jr.
Public Information Officer
Smithsonian Institution
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HERE CAN MAN GO...IN VEHICLE SYSTEMS?

Following the genesis of an idea, after theoretician and researcher have had their say, there results an end product from all that has gone before...a vehicle system. At Lockheed, these vehicle systems represent a deep corporate commitment. A commitment to extend mankind's capabilities both upon and above this planet in the years to come. For example, under the surface of the sea, one Lockheed vehicle system, known as Deep Quest—an extremely advanced two-place deep submersible—will explore the ocean depths. For land, Lockheed is using computers to design highly specialized ve-
cle systems for missions of the future. And in the
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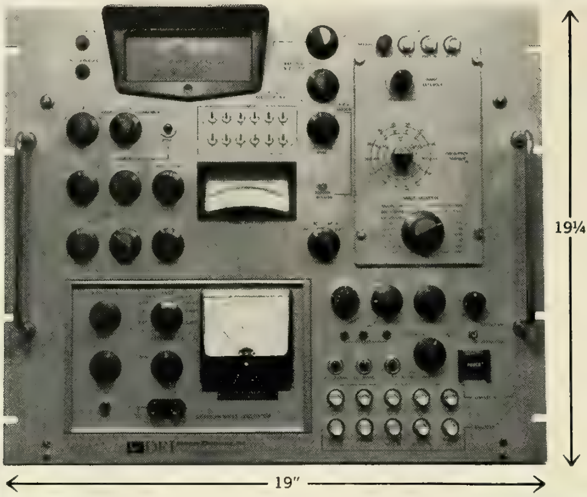

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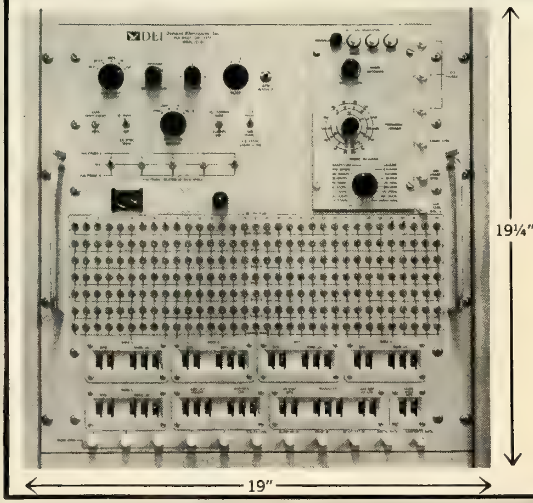

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The Countdown

WASHINGTON

Surveyor Launch Threatens to Slip to '66

It now looks very doubtful that the first launch of the *Surveyor* spacecraft will take place in late 1965 as scheduled. A key date on the tight schedule is Oct. 20, when the spacecraft is due to be shipped from Jet Propulsion Laboratory to Cape Kennedy. Even if it makes that target, there will be little time left before the end of the year to get it ready for launching. Any technical problems that crop up in the current testing of the spacecraft will certainly push the firing into next year.

Pioneer Holding to Schedule

Launch of the first *Pioneer* spacecraft is still slated for the last quarter of this year. The 120-lb. solar probe will be hurled out to a distance of 90 million miles from Earth by a *Thrust-Augmented Delta* launch vehicle.

Saturn V Flight Stage Right on Time

Roll-out of the flight model of the first stage of *Saturn V* took place on Sept. 27, just as planned. Date for the milestone event had been set a year ago, and Marshall Space Flight Center hit it on the button.

Unfinished Business on Capitol Hill

The House of Representatives, moving to adjourn sometime around the middle of October, will leave hanging several bills of importance to the missile/space industry. These include legislation to consolidate management of Government automatic data-processing activities, to create a scientific information management agency in the Executive branch to aid in top-level decision-making, and to study the feasibility of U.S. conversion to the metric system. All are expected to be taken up in January.

Comsat Moves Toward Apollo System

Communications Satellite Corp. was expected to file with the Federal Communications Commission on Sept. 30 for authority to award contracts for a satellite communications system for possible use in Project *Apollo*. The proposal for the system is still under study, but a decision is expected at any time. Hughes Aircraft Corp., builder of the *Early Bird*, was the only firm to submit a proposal for the satellite portion of the system. Comsat would also provide portable ground stations.

Kennedy Gets Goddard Launch Team

Goddard Space Flight Center's Launch Operations Group was officially transferred to the Kennedy Space Flight Center on Oct. 1. Its former director, Robert Gray, is now the Kennedy Center's assistant director for unmanned launch operations. He will also direct the operations of Goddard's former Western Launch Operations Group.

Northwestern Designing Apollo Camera

Northwestern University of Evanston, Ill., under a $90,000 contract from Manned Spacecraft Center, will design the camera and optics for photographing light spectra in the ultraviolet region emanating from stars and star fields during the manned *Saturn-Apollo* 207 mission in 1968. The camera will be mounted in the Command Module spacecraft airlock and will be used to obtain a large number of moderate-dispersion spectra of stars, and direct photographs of Milky Way fields.

SBAMA Out of Procurement Business

The San Bernardino (Calif.) Air Materiel Area (SBAMA) directorate of procurement and production was phased out effective Sept. 29. As of Sept. 30, all central procurement support functions for SBAMA missiles were assumed by Sacramento or Ogden Air Materiel Areas.

Aircraft Hurting for Lack of Standoffs

A top DOD official has voiced the need for air-to-surface missiles for tactical aircraft. Leonard Sullivan, assistant director for combat systems, DDR&E, told the Society of Experimental Test Pilots Symposium in Beverly Hills, Calif., that the airspace for safe flight in limited warfare is shrinking, as surface-to-air missiles force aircraft "into the corners of the flight envelope."

INDUSTRY

Lockheed Discovers New Isotope

Lockheed Missiles & Space Co. has reported discovery of a new isotope—Fluorine-22—at its Palo Alto, Calif., research laboratories. A team of scientists measured a half-life of about 4 sec. for the isotope after it was produced by a 15-million-electron-volt neutron bombardment of Neon-22.

Kaiser Studying Expansion of AAP Support

Henry J. Kaiser's Engineering Div., in Oakland, Calif., has won a $70,000 NASA contract for an investigation of the possibility of expanding present MSC mission control and data-handling capabilities to support the *Apollo* Applications Program (AAP). Among additions the contractor is to consider are a three-story, laboratory-office wing (116,000 sq. ft.), a multi-storied office building to house 800 AAP contractor and Government personnel, and extension of Mission Control Center emergency power facilities.

INTERNATIONAL

Japanese To Test-Fly Kappa 10 Booster

Japan's attempt to orbit its first satellite by Fiscal Year 1967 will take a major step forward shortly with a test flight of its *Kappa 10* launch vehicle. The important test, during which the booster will be guided into a horizontal position in flight as a prelude to putting payloads into orbit, will climax a series of rocket launchings from Kyushu Oct. 27-Nov. 10. An earlier series, not involving *Kappa 10*, began Sept. 25 and will conclude on Oct. 8. This series includes the launching of two *Kappa 9M* and *Kappa 8L* space observation rockets to study the ionosphere, galactic X-rays and other phenomena, as well as two *MT135* meteorological rockets. The second series begins with a *Kappa 9M*, a *PT160* and a *DS160* before the important trial of *Kappa 10*, developed by Tokyo University's Institute of Space and Aeronautical Science.

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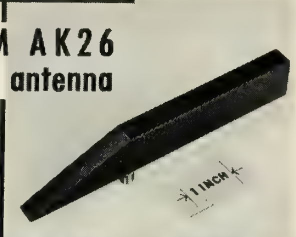

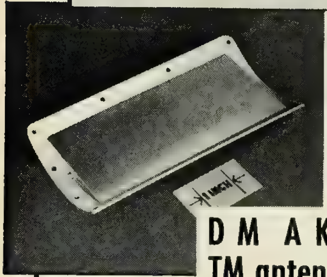

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The Missile/Space Week

Saturn IB Optimism Wanes

NASA is trying hard to get the first *Saturn IB* off the pad this December, but delays in checking out the first unmanned *Apollo* spacecraft may force return to the officially announced timetable, which calls for a launch in the "first quarter of 1966."

The *Apollo*, Number 009, will be the first instrumented spacecraft to fly, but will lack the fuel cell and some components of the life support system. It consists of Command and Service Modules only, with the Lunar Excursion Module scheduled for test flight later. Five boilerplate *Apollo's* have been launched so far from Cape Kennedy with standard *Saturns*, including three in conjunction with *Pegasus* spacecraft.

The *Apollo*, due at the Cape at the end of September, is still undergoing checkout at the North American plant at Downey, Calif., and presently is not due for shipment to Merritt Island until Oct. 8. It will probably arrive aboard Aero Space Line's "Pregnant Guppy" aircraft on Oct. 9, a date that would present "a very tight schedule" if a December launch were to be attempted, a highly placed NASA source told MISSILES AND ROCKETS. Any further hitch in shipping the modules would kill any possibility of a launch this year, according to this source.

The Service Module will first be taken to the Manned Spacecraft Operations Building for 2 days of inspection, then be trucked to Pad 16 for a static firing of about 15 seconds.

Cape Labor Strife Eases

Uneasy peace reigned over the Kennedy Space Center last week as the Army Engineers reported on Sept. 29 that all construction workers were on the job for the first time since Sept. 16, when the International Association of Machinists struck Boeing Co. on a nation-wide scale.

About 1,900 construction workers, who in the beginning of the strike honored picket lines at all entrances to the two Federal installations, began trickling back when NASA and the Air Force hit on the idea of designating one entrance as the Boeing gate and informed the IAM it would have to limit its picketing to the south entrance to Merritt Island.

Last Monday, fewer than 800 were off the job, affecting only construction of the Vehicle Assembly Building and expansion of the Manned Spacecraft Operations Building. By the middle of last week, the IAM pickets were still marching at Merritt Island Gate Number 2, but the backbone of the strike at the space port appeared to have been broken.

Bendix Gets STADAN Follow-on

NASA is negotiating with Bendix Field Engineering Corp. for a follow-on contract for operations and maintenance support of the Space Tracking and Data Acquisition Network (STADAN).

Value of the 2-year contract is estimated at $25 million. The agreement calls for service at STADAN facilities at Blossom Point, Md.; East Grand Forks, Minn.; Fort Myers, Fla.; Goldstone, Calif.; Lima, Peru; Santiago, Chile; Quito, Ecuador; and Tananarive, Malagasy Republic.

Titan III-C Readied for Oct. 8

A NASA-scheduled "wet mock" launch simulation for *Gemini 6* and its *Atlas-Agena* target vehicle system on October 7 has moved the launching of the second Air Force *Titan III-C* one day to October 8.

The Eastern Test Range cannot handle two such major tests concurrently and both boosters in the *GTA-6* simulation will be fully fueled during the countdown.

Titan III-C2, now on Pad 40, was assembled and transported through the new Integrate-Transfer-Launch facility. The Air Force Space Systems Div. vehicle was checked out on the pad. *Titan III-C3* will arrive on Pad 41 fully checked out in the first complete utilization of the ITL concept (M/R, June 21, 1965, p. 18).

Relay II Retired

The demonstration career of the *Relay II* communications satellite was ended last week with the shutdown of NASA's Mojave, Calif., station.

The station, the only one in the U.S. equipped to send and receive via *Relay*, will be remodeled for use in the *Applications Technology Satellite* program.

The Mojave station and the station at Blossom Point, Md., will retain command and telemetry capability, however. Therefore, Japanese and European ground stations may continue to work with *Relay* to observe how long the satellite operates.

Firms Team for Apollo Bid

Martin Co., Honeywell, Inc., and Radio Corp. of America plan to submit a joint bid for design of the *Apollo* Experiments Pallet (M/R, Sept. 27, p. 19).

The container, which will be developed by the Manned Spacecraft Center, will accommodate a variety of experiments associated with the *Apollo* program. First phase of the program will be a $375,000 definition study contract.

Under the firm's agreement, Martin will develop the main structure of the pallet, thermal systems, power systems and experiment integration. RCA's Astro-Electronics Div. will supply communications and data management and Honeywell will provide the attitude pointing subsystem.

Space Student Exchange Begun

The University of Tennessee Space Institute and the University of Aachen, West Germany, have started an exchange of faculty members and students.

An agreement setting up an international aerospace teaching and research program was signed by representatives of the two universities last month at Arnold Engineering Development Center, Tenn.

Dr. W. H. Dettmering, head of Aachen's Institute for Jet Propulsion and Turbomachinery, and four German students are now at the Space Institute. Arrangements are being made to send University of Tennessee students and faculty to Aachen.

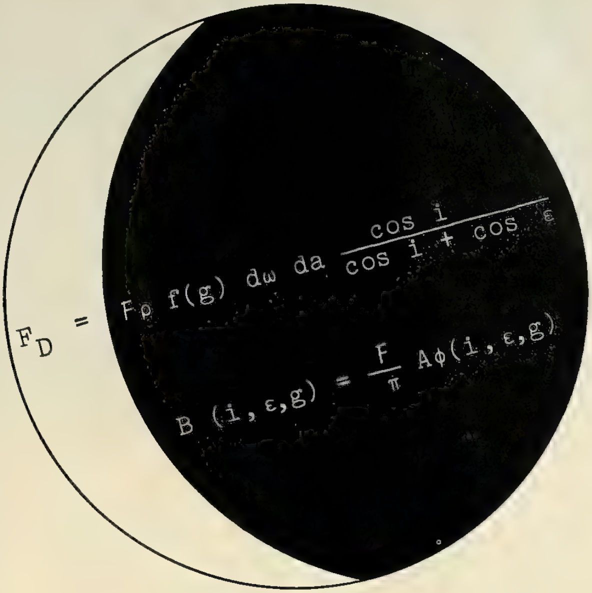
Sealab II Test Nears End

Astronaut M. Scott Carpenter emerged from Sealab II on Sept. 27 after 30 days in the sea.

The exercise was part of a 45-day man-in-the-sea program being conducted by the Navy off the coast at La Jolla, Calif. Two teams of 10 men each are spending 15 days in the sea chamber.

Shots of the Week

NASA on Sept. 17 and again on the 25th used *Aerobee 150* rockets to boost French payloads from Wallops Island, Va. Both shots carried instruments to check out experiments for France's *FR-1A* satellite, scheduled to be launched late this year aboard a *Scout* vehicle. Meanwhile at the Dallas plant of Ling-Temco-Vought, a team of French scientists were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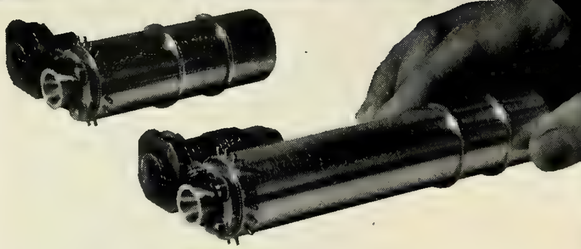

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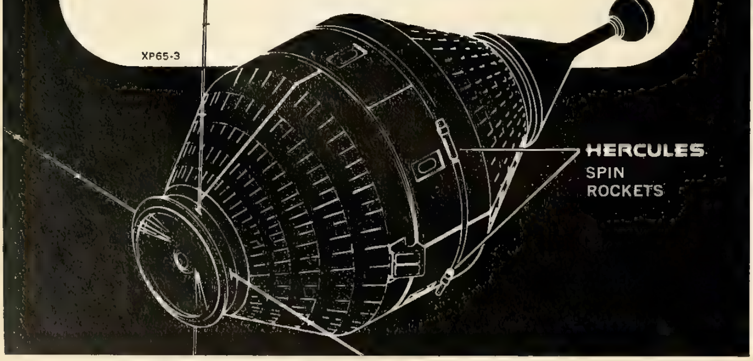

completing mating tests with the *FR-1* and the *Scout*. Scientific objective of the 135-lb. *FR-1* is to measure the propagation of very-low-frequency radiations in the Earth's magnetic field.

- All test objectives are said to have been met in the Sept. 23 firing of the Army's *Lance* battlefield missile at White Sands Missile Range, N.M. The missile was launched from a lightweight mobile launcher.
- The Air Force successfully launched a *Minuteman II* ICBM from Cape Kennedy Sept. 24. It impacted 5,000 mi. down the Eastern Test Range.
- NASA test pilot John McKay flew the *X-15* rocket plane from Vandenberg AFB, Calif., Sept. 28 to obtain boundary layer noise data.
- The Air Force on Sept. 29 launched an *Atlas-D* ICBM 5,000 mi. down the Western Test Range from Vandenberg AFB, Calif.

Lunar Study Director Named

Philip E. Culbertson has been named director of lunar mission studies in NASA's Office of Manned Space Flight.

He will be responsible for studies concerning manned lunar exploration in the post-*Apollo* period. Culbertson formerly worked for General Dynamics Corp. on the *Atlas* launch vehicle.

Mariner T/M Halted

NASA has halted daily telemetry from the *Mariner IV* spacecraft but may renew the radio link with Earth in 1967.

On Oct. 1, ground command switched the spacecraft's transmitter from the high-gain directional antenna to the omni-directional antenna. During the next two years, it will be possible to track *Mariner IV* only with a new 210-ft. antenna, which will begin operation in 1966 at the Goldstone, Calif., station. No telemetry will be received during this time, but periodic tracking of the spacecraft as it orbits the Sun will determine whether the transmitter is still operating.

Since its launch on Nov. 28, *Mariner IV* has transmitted to Earth nearly 50 million engineering and scientific measurements on the environment of interplanetary space.

Bowers New Convair Chief

Jack L. Bowers has been named general manager of the Convair Div. of General Dynamics Corp. He succeeds J. R. Dempsey, who resigned effective Sept. 25.

Navy and Air Force needed a tactical missile precise enough to hit a small target from two miles out; reliable enough to handle like a round of ammunition.

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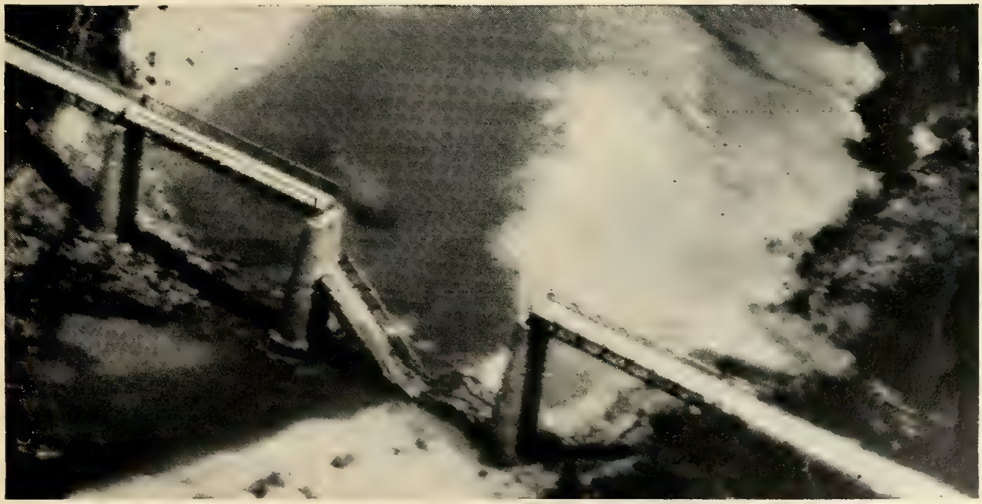

XOM CA TRANG BRIDGE shown with center span collapsed after a direct hit with a U.S. Navy Bullpup missile. Bullpup was developed by Martin.

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Voyager Program Facing Reorganization

Mariner IV evidence of thin Martian atmosphere leads to plan to drop Saturn IB-Centaur, make spacecraft bigger and costlier

by Hal Taylor

A MAJOR REORGANIZATION of the *Voyager* spacecraft which will sharply increase its size, cost and scope is likely to be announced by NASA this week.

A recommendation calling for major changes in the unmanned Mars exploration program has been presented by officials of the Office of Space Sciences and Applications to NASA Administrator James E. Webb. It is expected to be approved by Webb and other officials and made public promptly.

Among the major changes:

—The *Saturn IB-Centaur* launch vehicle development program will be cancelled.

—A planned flight test of the *Voyager* spacecraft and launch vehicle system in 1969 will also be cancelled.

—The planned operational mission in 1971 will continue as part of the program, but the *Saturn V* booster will be used as its launch vehicle. The 1973 mission will also be launched toward Mars by the *Saturn V*.

—The switch in launch vehicles will increase the size of the spacecraft, retro propulsion units, and capsule lander from 10,000 lbs. to 40,000-50,000 lbs.

—The total cost of the program is now expected to go well over $2 billion.

—Requests for proposals for preliminary design of the capsule landing system, originally scheduled to be issued later this year, will be delayed, but the length of the delay is not known.

It is possible that probes will be launched into the Martian atmosphere, perhaps by an *Atlas-Agena* or *Atlas-Centaur*, in an effort to obtain more information on its pressure.

• **Mariner dictates**—The recommendations stem from a recent review of the project by officials of NASA headquarters, the Jet Propulsion Laboratory and the Langley Research Center. This coincided with a reappraisal of the total NASA program undertaken by top space agency officials in connection with the preparation of its Fiscal Year 1967 budget.

The switches in *Voyager* plans were motivated primarily by data from *Mariner IV* indicating that Mars may have an atmospheric pressure as low as 5 millibars.

This means that the capsule lander will have to be much heavier than the capsules that could have been launched by the *Saturn IB-Centaur* booster. The additional weight is caused by the need for a much larger retro propulsion system to slow down the capsule's re-entry through the relatively thin atmosphere.

Previously, NASA officials had hoped to rely more heavily on atmospheric drag to slow the capsule.

In presenting the *Voyager* program to top management, the Office of Space Sciences and Applications gave them several alternative courses of action to achieve the project's goal of Mars exploration.

However, the one favored by project officials and expected to be approved by top management called for the cancellation of the *Saturn IB-Centaur* and the switch to the *Saturn V* and a larger spacecraft.

There still seems to be some disagreement within the scientific community as to whether the atmospheric pressure is the low 5-7 millibars reported by *Mariner* or the 10 millibars indicated by other, Earth-bound studies.

As a result, the initiation of a program to send probes into the atmosphere to obtain detailed data is possible, but a decision on this is not expected for some time.

• **Strap-ons out for now**—There had been rumors that the *Saturn IB-Centaur* would be replaced by a new launch vehicle consisting of an 120-in.-dia. solid motor strapped on to the booster's first stage and the S-IVB stage. NASA later denied the reports that the solid strap-ons would be used for *Voyager*, but did not discount the possibility that the vehicle might be developed some time in the future.

Both the *Saturn IB-Centaur* and zero-stage *Saturn IB* could deliver 9,000 to 10,000 lbs. to the vicinity of Mars for a *Voyager*-type mission. The *IB-Centaur* can deliver 13,000 lbs. escape payload, and *IB* with strap-ons 12,000 lbs.

There are numerous problems of integration with the strap-ons. ■

Western Electric To Develop Advanced Zeus System

THE ARMY HAS ORDERED development of an *Advanced Zeus* anti-missile missile which could greatly increase the effectiveness of the nation's anti-ICBM weapons system.

The project was initiated under a $21,580,454 contract with Western Electric Co. The new missile will have a range of 400 mi. out into space, twice that of anti-missile missiles now under development.

The firm also received a total of $228.5 million for continued development of the *Nike-X* anti-missile system.

Its added range would enable *Advanced Zeus* to meet incoming ICBM's and their warhead penetration aids before the latter could be deployed to confuse anti-missile guidance systems.

If the advanced missile were unsuccessful in destroying the penetration aids and the ICBM's with legitimate warheads before they enter the Earth's atmosphere, the Army *Sprint* missile could then be used to knock down any which have penetrated the *Advanced Zeus* system.

The new missile has been designated the DM15X2. It will employ two solid-propellant motors and carry a nuclear warhead.

A $221,216,696 contract was awarded Western Electric for continued development and testing of *Nike-X*. The cost-plus-incentive-fee award covers work from Oct. 1, 1965, to Sept. 30, 1966. An additional $7,283,304 will be used for research and development facilities for *Nike-X*. Work will be performed at Burlington and Winston-Salem, N.C., and Allentown, Pa.

Of the larger contract, $40 million will go to Martin Co. for continued development of the *Sprint* anti-missile missile. Martin will award $4 million to Hercules Powder Co. for the propulsion development.

The *Nike-X* anti-missile system, composed of the *Zeus* and *Sprint* missiles, has been under development since 1955 at a cost of over $2 billion.

Crawler Problems Won't Delay Apollo

Modification expected to eliminate cause of roller bearings being crushed; work proceeds on second transporter vehicle

MODIFICATIONS in an effort to solve problems with the crawler-transporter designed to carry the *Saturn V-Apollo* and its mobile launcher to Launch Complex 39A at Cape Kennedy will not jeopardize key milestone dates in the *Apollo* program, NASA has said with confidence.

The space agency said last week that confirmation of a solution was "imminent" and fabrication of new parts has begun at the plant of the prime contractor, Marion Power Shovel Co., Marion, Ohio. A number of solutions to the problem of crushed roller bearings in the huge vehicle were analyzed, NASA said, and one was chosen subject to completion of detailed design and confirmation through a test program.

House Space Committee member Rep. Olin Teague (D-Tex.), who is both chairman of the manned spaceflight and the NASA legislative oversight subcommittees, said he studied the problem several weeks ago, thought the problem was not serious and was well on its way to being solved.

"There is no question that an honest mistake was made," Teague said, pointing out that the vehicle is a first of its kind. The mistake was apparently in faulty calculations as to the necessary strength of the bearing system, he indicated.

Cost of the two crawlers to be procured is estimated at almost $12 million. Under the cost-reimbursable contract, Marion has to shoulder the expense of replacing any defective parts. If a design change is involved, however, NASA will have to stand the expense, having bought the specs.

Construction of crawler number two, halted when the crushed bearings were discovered on number one, is to be resumed except for the bearings and hydraulic leveling system, it was indicated. About six weeks of work lies ahead before these crucial systems are reached, by which time project officials hope to have worked out the engineering problems on the bearings.

• **First indications**—NASA said that the first sign of failure occurred July 25, during a comprehensive schedule of testing which had begun in April, on the first of the two crawler-transporters ordered for the program, prior to acceptance of the equipment.

While the crawler was transporting the mobile launcher on which the *Saturn V* vehicle and *Apollo* spacecraft will be erected, it was detected that failures had occurred in some track support roller bearings, which transmit the load from the crawler chassis to its treads. At this time, the crawler was on the crawlerway. It was driven back to the parking site, a distance of one mile, and then was driven to its erection site to determine the extent of the damage, NASA said.

The bearing system must support the combined weight of the crawler, launcher and space vehicle, totalling 18 million lbs. The rollers are designed to carry an unloaded weight of 3,000 lbs./sq. ft. and 9,000 lbs./sq. ft. when the crawler carries the mobile launcher and the *Saturn V-Apollo*.

According to NASA, when the crushed bearings were discovered, the testing was suspended and an engineering appraisal initiated by the Kennedy Space Center with the prime contractor. Marion employees removed the damaged bearings and supporting shafts.

A number of proposed solutions to the problem were evaluated by KSC. These were carefully analyzed, and an "acceptable engineering solution" was selected, NASA said.

A NASA spokesman at the Cape said that steering stresses resulting from heavy side thrust action affected the load distribution, and that the bearings themselves were not to blame.

Cape sources also said that Torrington Co., the subcontractor who supplied the roller bearings, will replace all 176 (8 sets of 22 each) by the end of October if no new problems are encountered. If all goes according to the new schedule, propulsion tests of crawler number one with the new bearings will take place in December, and a run with the 11.5-million-lb. mobile launcher is tentatively scheduled for January.

• **Labor pains**—Work on the crippled crawler and all other work at the crawler site was stopped Sept. 17, when Marion employees honored a picket line of the International Assn. of Machinists who had struck The Boeing Co. Further disputes occurred, it is understood, when Marion refused to pay the steelworkers honoring the picket line. With the charge that the contractor was not living up to its offside contract promises, the United Steel Workers of America, Local 1949, ordered 45 of its members working on the crawler to return to Ohio.

According to NASA sources at Cape Kennedy, only the steelworkers on crawler number one were taken off the job. Marion is negotiating with the union to provide the work force necessary, and at least for the present time, NASA says, it does not appear that the work stoppage at the site has been the pacing item in meeting the schedule.

• **Other problems**—While NASA has addressed itself publicly only to the bearings problem, there have been reports at Kennedy Space Center that the crawlers may be afflicted with another ailment—inoperative hydraulic leveling system that has resisted solution for nine months.

American Machine and Foundry, subcontractor for the leveling and steering system, is reported to be trying to correct the leveling deficiency. The problem involves the 16 hydraulic jacks which are reported not to be working properly and are causing the corners to be ±2 in. out of plane (M/R May 10, p. 17; Aug. 30, p. 12).

The leveling system is designed to compensate automatically for loads up to 12 million pounds, the combined weight of the 11.5-million-lb. mobile launcher and the assembled *Apollo-Saturn V* space vehicle.

The inaccuracy in the leveling, it has been indicated, causes an electrical signal to cut off automatically, shutting down the leveling system. This problem was reportedly found when the crawler was delivered for testing Jan. 23, but its source was not traced.

The crawler is 131 ft. long, 114 ft. wide and 20 ft. high, with cylinders extendable another 6 ft. It is designed to move unloaded at a maximum speed of 2 mph, loaded at 1 mph. When loaded, its cylinders will be extended about 3 ft. Normal pressure of the hydraulic system is 2,780 psi; maximum pressure is 5,000 psi.

The vehicle moves on four double-tracked crawlers, each 10 ft. high and 40 ft. long. When operational, it should be capable of handling curves up to a 500-ft. radius and a 5% incline while keeping its load within one-sixth of a degree of true vertical. ■

Gemini 6 Flight Could Last Five Days

Dispersion of planned orbits of spacecraft and Agena target vehicle might delay Gemini launch; MSC details flight plans

by Jinx Mercer

HOUSTON—The first space rendezvous and docking mission, scheduled to begin Oct. 25, may last anywhere from one to five days.

Details of Project *Gemini's* most complex flight plan to date were released by NASA's Manned Spacecraft Center in Houston.

The McDonnell *Gemini 6* spacecraft will be geared for liftoff 101 min. behind the *Agena* target vehicle, which at that moment should be 1,040 n. mi. downrange.

This launch arrangement, according to Edgar C. Lineberry of MSC's mission planning and analysis division, will put the two vehicles in phase with one another so that 3½ orbits later *Gemini* pilots Walter M. Schirra and Thomas P. Stafford will be within docking distance of the Lockheed *Agena.*

The spacecraft will "catch up" with the other vehicle in 3½ orbits because of orbital period differences.

- **Launch contingencies**—If the launch is nominal, Schirra will not have to correct out-of-plane dispersions. The plane error will have been steered out by the *Titan* vehicle during the boosted portion of flight, Lineberry said.

Schirra will have only to adjust the spacecraft altitude at alternating perigees and apogees to position the orbit exactly within that of the target vehicle and to leave an in-plane separation of about 15 n. mi. between the two orbits (36-n. mi. slant range) before beginning the terminal portion of rendezvous.

If the *Gemini* launch slips past the 101-min. mark, flight controllers will still be able to maneuver the two vehicles to within 1,000 n. mi. of each other for proper phasing up through the next 2½ hrs., Lineberry indicated.

The further *Gemini* slips into this period, the costlier the corrective maneuvers become. However, Lineberry said that at no time during this period will they be beyond their maneuvering capability. If the *Gemini* slips into the third or fourth day, he said, mission controllers may consider even the costliest maneuver with respect to vehicle capabilities to bring the two vehicles within rendezvous distance of each other.

- **Flexibility**—Constraints governing launch "windows" (acceptable out-of-plane conditions) and "window panes" (acceptable out-of-phase conditions within the windows) will eventually tighten to the point where neither spacecraft nor the *Agena,* nor the two in combined maneuvers, can effect a rendezvous, Lineberry explained.

"At this point, launch operations will be postponed to the following day when the ideal phase and plane conditions appear once again," he said. This favorable period repeats each day afterward during the five-day useful lifetime of the *Agena.*

By repeatedly juggling numbers in computer-driven trajectories, analysts discovered that they could increase the length of the launch window for the first-day launch by inserting the target vehicle into a plane that cuts across the equatorial plane at 28.87 degrees. This inclination angle establishes the *Agena* in a plane that 101 minutes later will come within 0.5 degrees of pad 19—first north of it, then south of it—for an unbroken period of 25 minutes.

Lineberry said they hope to use this "window" to launch the spacecraft. Although they may be accepting an out-of-plane condition, "for just a small additional cost of payload" they can steer out this plane error by yaw steering the *Titan II* booster. Azimuth adjustments to alter the launch trajectory can be fed into the booster's roll program on the pad right up to T — 3 min., he explained. When the total out-of-plane error builds up beyond GLV yaw steering capability, then the spacecraft is inserted parallel to the *Agena* orbit to minimize the out-of-plane angle.

In return for the payload-in-orbit cost of the yaw steering maneuver, the *Gemini* gains some 240 fps Δ V for additional orbital maneuvering—or one-third the onboard supply of propellant originally budgeted for correcting out-of-plane launch vehicle dispersions after the *Gemini* is established in orbit.

- **Next time around?**—Phasing, on the other hand, has been timed to move the two vehicles to within rendezvous distance of one another by the time the spacecraft nears its fourth apogee. However, the longer the spacecraft is held on the pad, the farther the *Agena* vehicle moves downrange in its orbit, and the farther "out-of-phase."

Roughly, for every 100 seconds delay on the launch pad, the spacecraft is forced to complete one extra circuit before it can begin the terminal portion of rendezvous. Lineberry explained that within a matter of minutes so many make-up orbits would accumulate that the spacecraft would have to spend a day just in catching up with the *Agena.*

In such an instance, the decision may be made to scrub the same-day launch and wait for the optimum window to repeat on the following day, or to accept the out-of-phase condition and maneuver the *Agena* to take out the large out-of-plane error built up after this long delay on the pad. When a hold on the pad moves the launch beyond the 25-minute window, it will also move it beyond the corrective capability of booster yaw steering. "Here, we would have to command the *Agena* to move into the spacecraft's orbital plane," Lineberry said.

"This plane change would occur at the nodal crossing about one and one-quarter orbits after spacecraft insertion. Knowing that we have to make a large *Agena* plane change, we would probably delay the rendezvous two orbits—from the fourth apogee to the sixth apogee—to make sure we could recover from any dispersions."

Moving beyond this period of time and up to 95 minutes from the leading edge of the launch window, he said, three maneuvers would have to be commanded from the *Agena*: one, to fire the target vehicle into a larger "dwell" orbit where its orbital rate would become relatively slower to compensate for the large buildup in the out-of-phase condition and to allow the spacecraft to catch up at a faster rate; two, to bring it back into its 161-n. mi. circular orbit; and three, to correct the out-of-plane error. The burn to correct the plane misalignment would be made at the nodal crossing of the two orbital planes, and for a 95-min.-late launch, it would require 2,000 fps of the total 5,500 fps Δ V capability.

Beyond 95 minutes, the two vehicles would again return to favorable phasing, but the out-of-plane error in this region would require an expenditure of more than two-thirds of the *Agena's* total onboard maneuvering capability to nullify rapidly increasing out-of-plane divergence, he said. Mission controllers will consider this burn only if the *Gemini* slips into the fourth or fifth day behind the *Agena* target vehicle launch.

• **Pilot approach**—After launch and subsequent orbital adjustments have been completed by ground control, the spacecraft will be in the optimum position for completing the terminal phase of rendezvous—15 n. mi. below and 32 n. mi. behind the target.

At this point, control of the rendezvous transfers to the spacecraft, using the onboard interferometer radar with *Agena* transponder and the onboard computer. Range, range rate, azimuth and elevation data will be collected by the radar for short periods and compared to inertial platform data in a special program. Computer output will indicate to the pilots the necessary velocity vector changes that must be made to achieve rendezvous.

Schirra will initiate terminal maneuver by applying enough forward velocity (33 fps posigrade delta V) thrust to move the *Gemini* out of the inner orbit and toward the outer orbit of the target vehicle. The maneuver will begin 130 degrees of orbital travel back from the rendezvous point and when his look angle up to the target is 27.3 degrees from his local horizontal.

"Originally, we specified that the rendezvous location occur at the midpoint of darkness," Lineberry said, explaining that the pilots needed the star background for a frame of reference. "Now we shifted the rendezvous point to occur two minutes prior to coming out of the dark side of the orbit, with the terminal phase beginning about one minute into darkness after spacecraft sunset."

He explained: "We wanted to be sure that we would be able to see the *Agena* at the greatest possible distance by utilizing the high contrast of its flashing lights against the night sky background."

Lineberry said the initial braking maneuver probably will occur during darkness and the docking phase probably will occur on the day side of the orbit. "During the terminal phase, the pilots will inertially reference their platform. This would be the same as having a star background," he said. Thus, in the event of platform failure during the terminal phase, the pilots can easily transition their frame of reference to the flashing *Agena* lights in the star background.

• **Immelmann maneuver**—Earlier, at a press conference, Schirra described the pilot's point of view:

"We will end up finally coming up below the *Agena* and ahead of it, much like the maneuver that we describe in aviation as an 'Immelmann.' We will have our heads down (toward Earth) and will be just about approaching the top of a loop still slightly pitched up.

"At that point—approximately 3,000 feet out from the *Agena*—we will start retarding our closing velocity from 43 to about five fps. From about 40-50 feet on we will be tracking line-of-sight," he said, and decelerating to about one-half fps to dock.

GEMINI 6 spacecraft and its Agena target vehicle, shrouded in cocoon, are prepared for space docking exercise by NASA personnel at Cape Kennedy's Radio Frequency Systems test site. Covering provides controlled climate for instrumentation while radio and radar systems are coordinated and adjusted.

After rigidizing the two vehicles, Schirra said, they will perform attitude and maneuver changes using first the spacecraft Orbital Attitude and Maneuvering System (OAMS) and *Agena* cold-gas jet attitude control and stabilization system to study dynamic interaction and flexure at the docking adapter.

Several Dept. of Defense experiments will be performed within the proximity of the vehicle. One (D-2) will require circling the vehicle in plane at a radial distance of about 60 ft. to take still and motion pictures of the object against variously lighted backgrounds. Another (D-3), known as "mass determination," will evaluate a technique for measuring mass of orbiting objects by accelerating the object (*Agena*), using spacecraft thrusters and measuring velocity change versus time.

Repeated from earlier flights are several other experiments in various types of photography.

A second maneuvering stick added to the right side of the *Gemini* cabin will enable Stafford to guide the *Gemini* into the *Agena* docking collar. The attitude controller, on the center console, can be used by either pilot. Schirra said each pilot will have two attempts at docking—once on the day side and once on the night side. ■

Solids Support Mounts in Congress

Aerojet-General's firing prompts encouragement for full development of 260-in. motor despite NASA's lack of funds

by John F. Judge

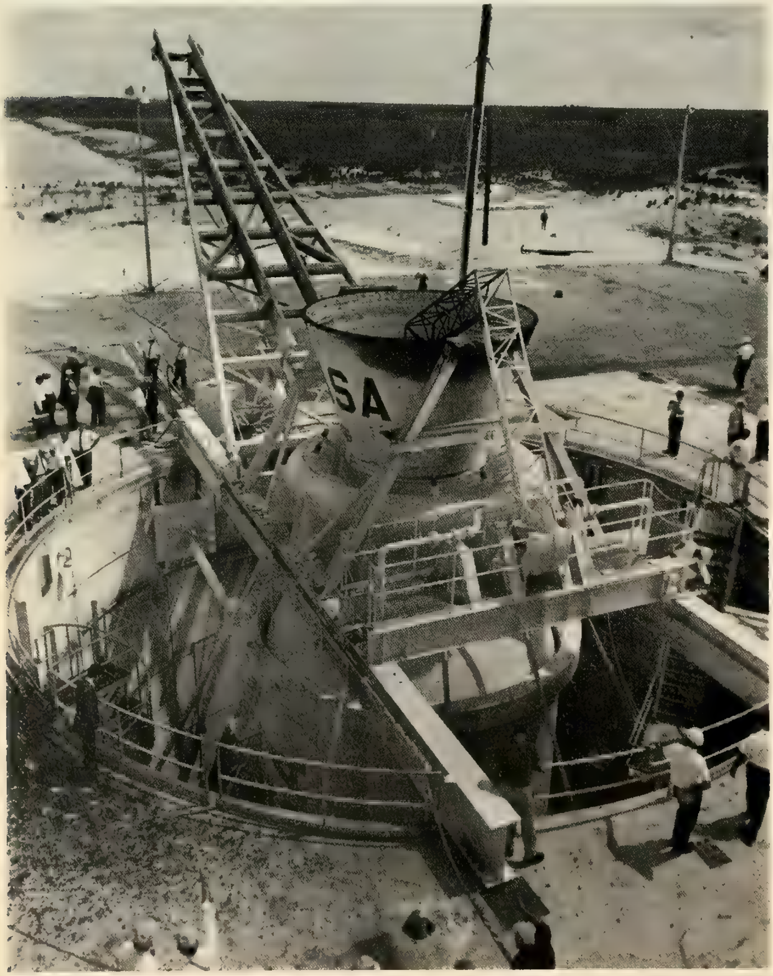
HOMESTEAD, FLA.—The first successful test firing of a 260-in.-dia. solid motor by Aerojet-General Corp. has substantially increased chances for meaningful funding of large solid boosters.

An enthusiastic Congressional delegation observed the firing. Rep. Ken Hechler (D-W. Va.), chairman of the subcommittee on advanced research and technology, House Committee on Science and Astronautics, called for NASA to proceed "without further delay" to carry forward the full development of the 260-in. motor.

Other House members present at the firing included Rep. George P. Miller, (D-Calif.) chairman of the House Committee on Science and Astronautics, Rep. Joseph E. Karth, (D-Minn.), Rep. Edward J. Gurney (R-Fla.), Rep. Gale Schisler, (D-Ill.), Rep. Dante B. Fascell, (D-Fla.) and Rep. Claude Pepper (D-Fla.). Gurney and Fascell are Space Committee members.

Top NASA officials indicate the agency is willing to proceed with the large-solid program, but the major concern is funding. The 260-in. large-solid-rocket feasibility program is part of the chemical propulsion effort in NASA's Office of Advanced Research and Technology. The space agency's Lewis Research Center, Cleveland, manages the solid program.

SL-1 AFTER Sept. 25 firing shows pivoting coolant injector inserted into exhaust cone. Blackened area on nozzle was probably caused during insertion of cooling rig.



NASA propulsion experts at the firing said the agency hopes to recover as much as $5 million from the cancellation of the program portion at Thiokol Chemical Corp. Thiokol's 260-in. effort was killed by NASA after the motor case burst during a hydrotest. Termination negotiations will go on for several months yet.

The future of large solids remains hazy in spite of recent test successes. The Bureau of the Budget sliced the 260-in. program out of NASA's Fiscal Year 1966 budget request and the space agency has not made a definite commitment to continue large solids. Congress replaced some of the funds.

Rep. Karth said he hoped NASA will spend the $13.2 million available for large solid development in FY '66. This money, together with the monies recovered from the Thiokol contract and FY '67 funding would permit static firings of full-length 260-in. motors in FY '67.

- **Performance**—The motor developed a peak thrust of 3.5 million lbs., with a chamber pressure of 600 psi. Total firing time was 124 sec. Thrust peaks extended over 112 sec.

SL-1 was fired in its casting-cure pit—designed by Aerojet to handle full-length 260-in. solids (M/R, Dec. 2, 1963, p. 29). One more such firing, SL-2, is scheduled next January, marking the end of the large solid program as it is currently funded.

Aerojet has received some $25 million to date in the program and invested an additional $23 million in facilities and land in Dade County, Fla., to handle large solid-rocket programs.

The motor was ignited by a solid unit generating about 250,000 lbs. thrust. This unit broke free of its restraining cables, flew several thousand feet into the air and impacted hundreds of feet from the firing pit. The igniter unit was designed to over-ignite the 260-in. motor—which had 500,000 sq. in. of propellant surface exposed to the ignition flame. The cross-section of the propellant core was clover-leaf shaped.

• **Thrust-busting**—The SL-1 (Short Length-1) exceeded its predicted perormance. Before the test, Aerojet's Richard F. Cottrell, manager, solid ocket operations, said the motor would each a peak thrust of 3.28 million lbs. t hit 3.5 million libs.

The predicted chamber pressure was 570 psi. It reached 600 psi. The motor hrust was programmed to average 3 million lbs. for the first 60 sec. The hrust then was to gradually reduce to he end of the motor action time.

Thrust just before the end of the run vas to be about 2.5 million lbs. The otal predicted power was 371.5 milion lbs.-force/sec. Programmed duraion was 140 seconds. Propellant was to e consumed at the rate of 6 tons/sec. Peak thrust was to have occurred 40 ec. after ignition. The 6-ft. nozzle hroat was designed to expand only 1 n. through temperature and erosion.

The firing data is now being procssed and detailed information on acual motor performance is expected this veek.

• **Solids progress rapidly**—The test iring indicated that there are no inurmountable problems in the design nd fabrication of the two major components of such motors—the nozzle nd the motor case.

Solid rocket technology has moved wiftly from the *Minuteman* and *Polaris* izes through the 120-in. booster stage nto the 156-in.-dia. area and now to 60-in. The 120-in. solid booster is curently in its initial flight testing phase n the *Titan III-C*.

The 156-in. program, directed and unded through the Air Force Systems Command, Space Systems Div., is eaching the static test phase at Lockeed Propulsion Co. Thiokol Chemical Corp. and Lockheed Propulsion have oaded and fired 156-in. motors.

The half-length 260-in. firing unit vas a demonstration motor only and vould require substantial development o reach the flight test point as a booster tage. Many systems such as thrust terination, thrust vector control, vehicle ransportation and launch stands would ave to be developed and tested. Solid ocket experts say all this technology s in hand.

• **Nozzle particulars**—The overall ength of the nozzle with its exit cone is 0 ft., 5 in. TRW Structures Div. fabriated the unit in the Cleveland plant. The nozzle assembly consists of five najor components—shell, inlet rubber nsert, inlet plastic insert, plastic throat nd plastic throat extension.

Initial visual surveys of the throat rea showed a uniform erosion and no ndication of failure modes. The throat nd other ablative areas in the nozzle sed carbon and silica cloth impregated with a phenolic resin.

The TRW fabrication scheme avoided the use of large autoclaves in building the massive nozzle. There are no size limits to such nozzles with the winding and pressure techniques perfected by TRW Structures Div.

The 16-ton nozzle is designed to withstand the loads that might be imposed by several thrust-vector-control systems. No such vector ability was designed into the Sept. 25 firing and there are no plans to include TVC in the next half-length firing. TVC is one of the subsystems that would be programmed into any future large solid project.

• **Motor details**—The total weight of the loaded motor is 1,862,802 lbs. and the design is such that it needs only be made longer to provide more power.

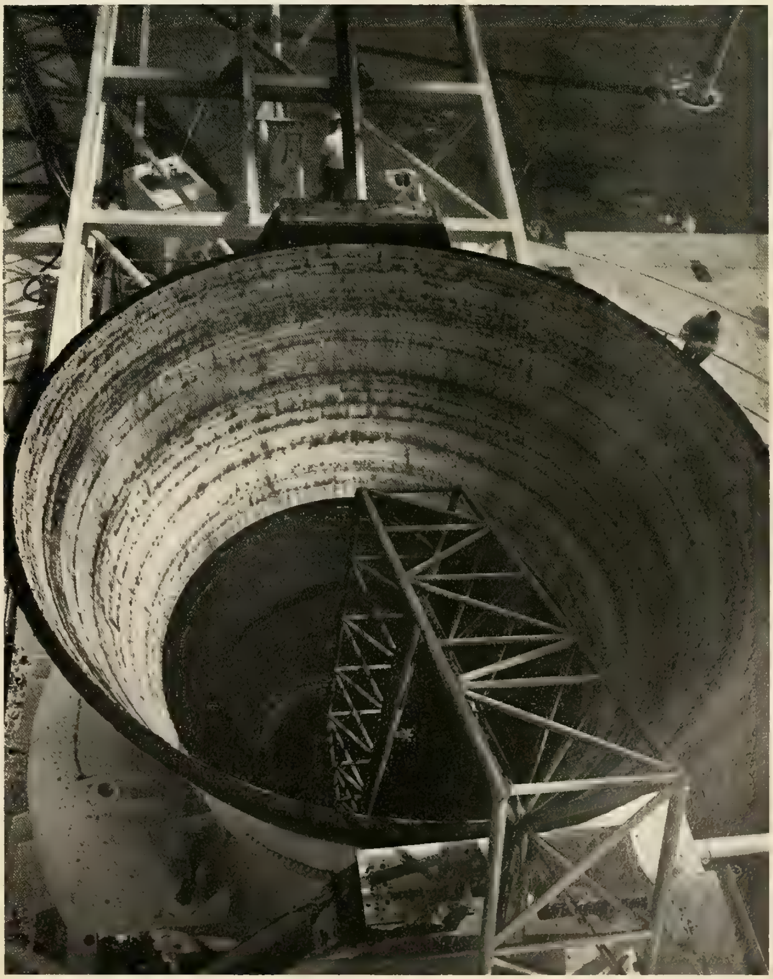
The chamber is 60 ft., 3 in. long and fabricated from 18% Ni. maraging steel by Sun Shipbuilding and Drydock Co., Chester, Pa. The steel is an 18% nickel, 7-8% cobalt, 4-4.5% molybdenum composition having a minimum yield strength of 200,000 psi. All welding performed by Sun used the automatic tungsten inert gas process.

The steel plate was supplied by Republic Steel Corp., Cameron Iron Works and Allegheny Ludlum Steel Corp. Maraging ingots for all major chamber and nozzle shell forgings were also supplied by Republic. Ladish Co. produced the rolled ring forgings.

Approximately 10 tons of Gen-Gard V-44 General Tire and Rubber Co. material was used to insulate the motor case and aft closure section. Goodyear Tire and Rubber Co.'s Aviation Products Div. formed the insulation and installed it at the Dade facility.

Ablative materials for the nozzle were provided by Fiberite Corp. ■

POST-FIRING INSPECTIONS of nozzle showed uniform erosion of ablative throat and extension cone sections. Development of materials and fabrication techniques for such nozzles was key item in large solid program. TRW's nozzle demonstrated efficacy of pressure-winding-temperature technique avoiding use of big, costly autoclaves. Nozzle performance details are still to be announced.



MOTION MEASUREMENT REPORT CEC

REPORT NUMBER 4

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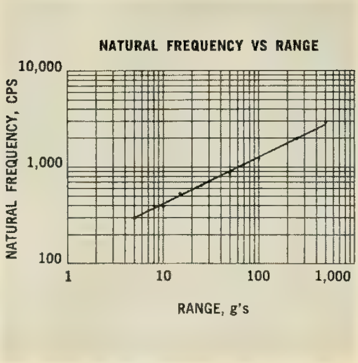

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▣ **Rated Voltage** – 28 v d-c; Input Current – 50 ma maximum at rated voltage at 77°F.

▣ **Electrical Overload** – 45 v d-c for 500 milliseconds maximum will not damage transducer or cause output to exceed 150 mv peak-to-peak.

▣ **Regulation** – a voltage variation of ±2 v from rated voltage will shift residual unbalance less than ±0.5% and full range output less than ±0.25%.

▣ **Warm-Up Time** – residual unbalance and sensitivity is within 0.1% of full range output of final values 5 min. following application of rated electrical power.

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▣ **Residual Unbalance** – within ±2% of full range output at zero acceleration, rated excitation and 77°F.

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Technical Countdown

PROPULSION

Centaur Not Structurally Weight-Limited

A fully loaded, operational *Centaur* launch vehicle can upport some 38,000 lbs. if the load is attached to the orward dome/tank joint. The load ability is considerably ess if the supporting ring rests on the dome itself, but exeeds the *Surveyor* weight by a comfortable margin. Grant . Hansen, vice president and *Centaur* program director at eneral Dynamics/Convair, told MISSILES AND ROCKETS that he vehicle can support structural loads capable of "busting" ny booster now operational. (These loadings are not space ayloads but merely the upper weight limits the *Centaur* an structurally support.)

hiokol Fires Large Submerged Nozzle

A submerged gimballed nozzle with a 15-in.-dia. throat ection successfully passed a static test firing using a motor omparable to a *Minuteman* first stage at Thiokol's Wasatch iv. The motor fired for 50 seconds with chamber pressures bove 800 psi and a flame temperature close to 6,000°F. hrust level was 200,000 lbs. Thiokol engineers are scaling he submerged nozzle concept up to a 25-in. throat diameter ased on the success of this and previous static firings. The im of the program, funded by the Air Force Ballistic ystems Div., is to develop technology applicable to large olid ICBM's in the 1-million-lb.-thrust ranges. The 25-in. ozzle will be demonstrated on a 120-in-dia. solid motor sing an advanced high-burning-rate, high-performance proellant. The first test is scheduled for late this year. Initial ests indicate that volume-limited solid motors achieve a 5% performance improvement through submerged nozzles.

MATERIALS

artin To Study Advanced Explosive Forming

Martin-Denver will develop explosive forming processes o produce uniform and precise dome-shaped structures nder a 22-month, $190,214 contract with the Air Force aterials Lab. The domes will reach 50 ft. in diameter and volve maraging steels, steel alloys and aluminum alloys. he three-phase program will cover materials evaluation, ncluding limits of deformation, data verification by fabriation and comparative studies to determine the best die aterial. The Martin Co. division recently won a $1-million OD contract to establish a high-energy-rate forming procsses center at Denver.

SPACE MEDICINE

hysiological Data Determined by Radar

Radar may be an effective medical tool for remotely onitoring a human being's blood pressure, pulse rate and ther physiological conditions, scientists from Cornell Aeroautical Laboratory say. Using a laboratory developed -band, CW radar, located 15 ft. from the test subjects, easurements of pulse and respiration rate were obtained. nformation could be determined on blood pressure, pulse ate, breathing amplitude, breathing rate and peripheral esistance by this means. The radar was augmented with a hase-lock loop to eliminate variables in sensitivity, making possible to differentiate between fluctuations caused by reathing and heart pulsation. The coherent ranging radar is capable of measuring range displacements of less than 0.0005 in., CAL said.

Astronauts Need Danger Threat Tests

There is a real need for studies on the effects on human behavior of threats of physical damage, a Navy scientist from the School of Aviation Medicine says. While the anticipatory stress—such as danger of crashing—may result in improved performance by a pilot or astronaut, the stress could also pass the optimal amount, resulting in deterioration of his performance. Dr. Robert Wherry suggests that studies should be undertaken in which threatening—but safe—situations could be used in laboratory settings on a number of subjects in repeated exposures, and reliable measurements made of their ability to perform.

ELECTRONICS

Uprated SECOR Satellites Planned

The Army Engineer Geodesy, Intelligence and Mapping Research and Development Agency will achieve high-altitude capability with four new satellites and electronic equipment to be produced by Cubic Corp., San Diego, Calif., under a $500,000 contract. Altitude of the current *SECOR (Sequential Collation of Range)* satellites, operating at 600 mi., will be more than doubled. The new vehicles, capable of operating up to 2,500 n. mi., will enable land masses 2,200 mi. apart to be geodetically tied together. New satellites will be about 12 in. wide, 14 in. long and 10 in. high, weighing 45 lbs. Each will contain a new high-altitude *SECOR* transponder capable of operating for a year. Delivery is to be completed by next June.

Mobile HIPAR Added to Hercules

A new mobile high powered aquisition radar system will be added to the Army's *Nike-Hercules* air defense units in the field. The mobile HIPAR system will give field units the same full target detection ability now existant in fixed *Hercules* systems in the U.S. Produced by General Electric Co. under a $8,134,430 contract from the U.S. Army Missile Command, the mobile system will have five semitrailers, each pulled by a 5-ton truck tractor. One rig will carry the 43-ft. fan-shaped antenna in dissembled form, and two other rigs will carry two prime power generators. Previously, transporting the large radar system was time consuming and involved more than 30 vehicles.

LIFE SUPPORT

Prototype Astronaut Couch Tested

Prototype development of a soft-cushioned, contoured couch for astronauts or pilots in high-speed and low-level aircraft has been completed. The design of the contoured multi-layered foam cushion is such that it can be used to fit a wide range of body sizes, its developers at Aircraft Armaments and the Navy's Aviation Medical Acceleration Laboratory say. The couch, which has been named the universal pilot couch, has been tested in the human centrifuge at the Navy's Air Development Center at Johnsville, Pa., at up to 12 g's. During acceleration, the foam molds to the shape of the subject, supporting the sides of the abdomen to prevent lateral displacement of the soft internal organs. Vibration and shock tests also were conducted.

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PREVIOUSLY UNATTAINABLE urity levels in materials may soon e reached through a technique deeloped by Dr. Charles P. Saylor of he National Bureau of Standards Instiute for Materials Research, Washingon, D.C.

The method was described to the 965 annual meeting of the American hemical Society as having many of the esirable features of conventional purifiation procedures without their disdvantages.

The Saylor technique is a single-tage purification, which takes about 30 inutes and reduces the amount of npurity present to less than 1/1000 of he starting concentration. It is believed hat multi-stage application of the techique can produce absolutely perfect rystals.

Dr. Saylor believes that his techique provides for additional stages of urification providing the same proporional impurity reduction as the initial tage. There is widespread belief that as he impurity in a substance is reduced, he difficulty of further impurity reoval increases to the extent that absoute purity can never be obtained.

- **Total purity possible**—A previous heoretical paper delivered by Dr. aylor before the 20th Congress of the nternational Union of Pure and pplied Chemistry (IUPAC) in Mosow detailed the NBS expert's conviction that it is simply the inability of cientists to measure ultrapurity and the ack of a technique that avoids reontamination during operation that inder attainment of a perfect end roduct.

Investigations using ultrapure maerials often lead to new realms of appliations since the end use of most aterials is limited largely by a lesshan-complete understanding of their haracteristics.

- **Process details**—The apparatus sed in the NBS technique consists of hollow ring that rotates slowly about s axis. The material to be purified fills bout half the inner volume of the ring and is melted using an external heater.

Strips of silver sheet—which remain stationary with respect to the rotating ring—are placed around the bottom half of the ring at equal intervals. The lower temperature of the strips causes material close to them to freeze on the inner surface of the ring. This forms a solid mound of crystalline substance.

As the ring moves, the front end of the mound—which has grown in a cold region—starts to melt as it approaches a warmer region. Growth continues on the rear edge of the mound as long as it remains under the influence of the cooling strip.

The melted material from the front edge flows over the mound and some of it re-freezes on the rear edge. Because of the growth configuration—the coupling together of particles as they grow on each other—molecules of the substance being purified tend to grow on the rear surface in preference to any impurity molecules that might be present.

Dr. Saylor says that such preferential growth is the basis of most purification by freezing or melting procedures, including the widely used zone melting technique. But the NBS process provides for the collection of the purified material and the transportation of concentrated impurity away from the growth area. The concentrated impurity is removed from the system and new starting material is introduced during operation.

As molecules of the substance being purified grow preferentially on the rear edge of a mound, some material will be melting from the front edge. Therefore, says Saylor, a particular molecule will actually move through the mound, its position changing as new molecules grow behind it and molecules in front are melted off. The speed with which it moves through the mound will be determined by the speed at which the ring is rotating.

The impurities flow along canal-like passages between the mounds until they reach a point where provision has been made to withdraw them. After repeated freezing and melting, the purified substance can be removed.

New material can be introduced at another point during operation—usually in amounts equal to that of the concentrated impurity removed. Saylor says the removal of impurity is a particularly important part of the process. In other purification techniques, impurities are concentrated and trapped in pockets within the growing crystal—thus prohibiting absolute purity unless removed by other means.

- **Molecular levels**—Under favorable conditions and proper control, the mole fraction of impurity can be reduced by at least a factor of 10^3, and, quite possibly, 10^4, says Saylor.

This strong rejection factor is achieved because the mounds are never allowed to melt completely. As they melt on one edge, growth takes place on the other edge and the result is a continually improving crystalline purity.

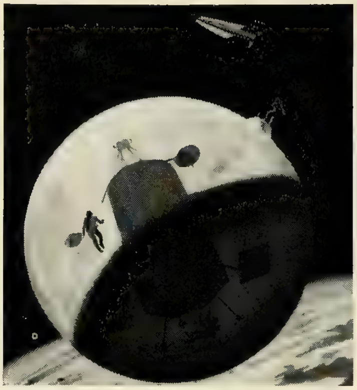
Dr. Saylor says this impurity reduction will be the same for succeeding stages. Thus even highly impure materials may be used to produce absolutely perfect crystals in short periods of time.

For example, if a mole of material is assumed to have 0.1% impurity, there should be approximately 6 x 10^{20} molecules of impurity present. If the impurity is reduced by a factor of only 10^3 per stage, at the end of six stages the impurity should be only 600 molecules per mole—and after seven stages, the chances are almost 2 to 1 that not a single impurity molecule will be present in the mole.

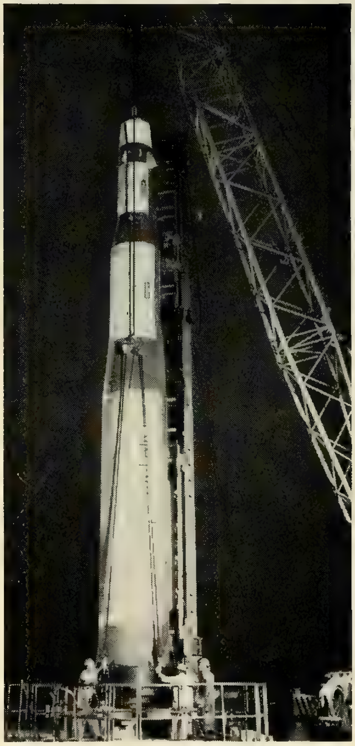
Putting the material through additional stages would further reduce the possibility that not even one impurity molecule remains.

Dr. Saylor's work was done as part of the Institute's program of research to develop standard reference materials for calibration of analytical instruments and procedures. Recent improvements in analytical methods have created a need for reference materials of ultra-high purity. ■

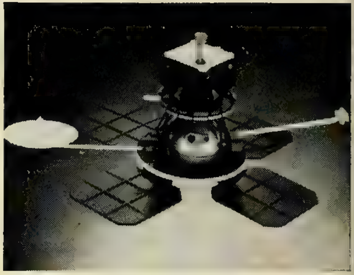
Space-Age Boeing Openings for Engineers and Scientists



Huge plastic cocoon could serve as space assembly "balloon," providing protection from solar radiation and temperature extremes. Proposal co-authored by Boeing bioastronautics scientist.



Advanced Minuteman II ICBM incorporates many improvements, including larger payload capacity, longer range, more sophisticated guidance system, increased accuracy.



First Lunar Orbiter flight, scheduled for next year, will seek out Apollo landing sites with sharp, detailed photographs of moon's surface. Boeing is building eight Orbiters for NASA.

The Boeing Company's deep involvement in the nation's most important missile and space programs is providing qualified engineers and scientists career opportunities of unusual scope and growth potential. Boeing currently is weapon system integrator for the U.S. Air Force advanced Minuteman II ICBM, prime contractor for the National Aeronautics and Space Administration Lunar Orbiter moon-scanning satellite, and a major contractor on the NASA Saturn V launch vehicle.

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Service Engineering
Mechanical Design
Structures Analysis & Design
Computer & Logic Circuit Development
Industrial Engineering
Electronic / Electromechanical Parts Evaluation
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NOL Tunnel Advances Arc Heater Art

New facility operating on three-phase a-c power promises to cut costs of equipment and power in re-entry simulation

by William S. Beller

THE NAVAL Ordnance Laboratory next week will start a new facility that may point the way to arc tunnels that are cheaper to build, operate and maintain than conventional ones.

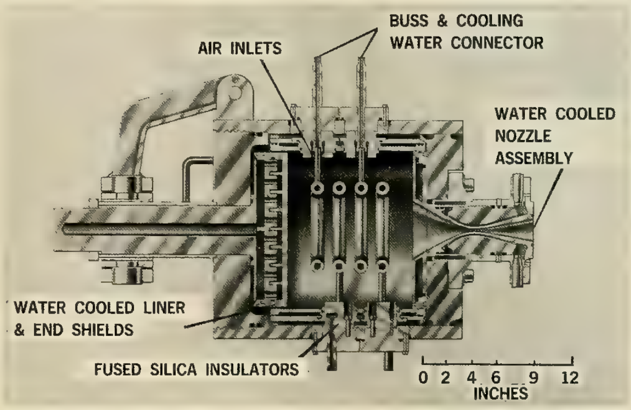
These are important considerations in view of the 42 arc tunnels that already exist in this country and the expanding interest in devising new ones to get accurate data for the aerodynamic design of vehicles in hypersonic flight.

The key to the promised economy is that the new arc tunnel operates on three-phase a-c power. Equipment costs as well as power costs are reduced.

"This is one of the few true-temperature, high-speed tunnels," according to Dr. Eva Winkler, chief of NOL's high-temperature aerodynamics group, "and probably the only one using three-phase power for its arc heater."

Most other tunnels use d-c power for their heaters, although some variants use three single-phase a-c power inputs. Avco Research and Advanced Development Div. introduces two or four d-c arcs into one plenum to heat he working gas.

The arc tunnel is the only practicable way known to simulate the very high emperature flow a vehicle experiences during re-entry into the Earth's atmosphere.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Navy's 3Mw Three-Phase Arc Heater Assembly Mark IV

- **Air is working gas**—In an arc unnel, a high-temperature arc, by means of heat transfer, raises the enthalpy of a high-speed gas flowing by. This gas is usually nitrogen, but to more nearly simulate hypersonic flight, NOL uses air. The high-energy gas then exits hrough a nozzle into the test cell, and exhausts into a diffuser.

The NOL tunnel will be used for heat transfer studies, ablation research, skin friction drag studies, all under either simulated re-entry flight conditions or flight above 100,000 ft. The first program to be performed is for the Bureau of Naval Weapons, which is seeking a way to protect the sharp leading edge of airfoils subjected to tunnel flow. Methods that will be investigated include ablation techniques, changed geometry, convection cooling and transpiration cooling.

- **High-power operation**—"We think we can support a 2-in.-dia. model plus its supports without air breakdown," Dr. Winkler told MISSILES AND ROCKETS. The tunnel is designed for an input of 3 megawatts of three-phase a-c power. The working cycle is limited to two runs of 2 minutes each at full power input for an 8-hour period. Mach numbers attainable are 4.5, 7.5, 9.5 and 11.0, she said.

The usual operating conditions at the test section are expected to be at Mach 9.5—i.e., pitot pressure of 20 mm Hg and stagnation temperature of 4,500°K—according to Richard Humphrey, NOL research aerospace engineer who worked on the tunnel design, instrumentation and operation. Dr. Winkler directed the design and development of the arc tunnel, based on initial heater development work performed for NOL by General Electric Co.

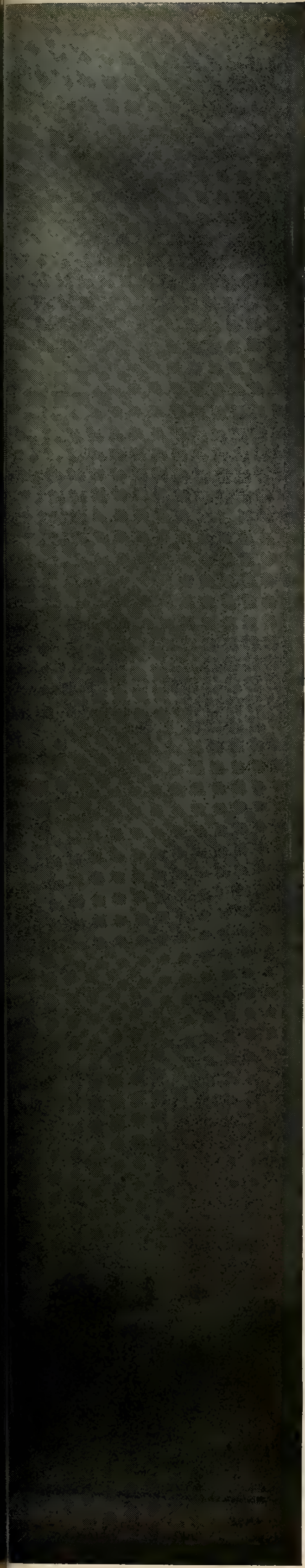
For the stated operation conditions, a 20-atmosphere supply pressure is needed. Maximum supply conditions available are: 60 atmospheres pressure, 6,000°K stagnation temperature, and 5,500 Btu/lb. enthalpy.

The chief contribution of the NOL tunnel, according to Dr. Winkler, is that "it advances enormously the theory and practice of a-c arc heaters, and points the way to larger arc heaters that are equivalent to or surpass d-c arc heaters in efficiency and enthalpy levels."

Figuring roughly, she said that for equal efficiencies, the d-c arc heater probably costs about twice as much as the a-c because of the additional money that would have to be spent for the transformer and rectifier for d-c operation. She sees similar economies in maintenance and power costs.

NOL will soon get a newer arc heater assembly, the Mark IV. In this, the working gas is introduced parallel to the face of the heater coils instead of normal to them. In this way, each electrode receives a similarly constituted gas instead of the first electrode getting a cold, un-ionized gas, as in straight-through flow.

NOL is eager to take the next step in arc heaters, the constricted a-c arc, used with such good results in d-c work. It gives increased efficiency as well as enthalpy. But the press of test work is so far preventing NOL from taking up the new work. Meanwhile, the Air Force and Westinghouse Electric Corp. are said to be working on a pilot a-c heater arc, with plans for an eventual 300-Mw, three-phase a-c facility. ■



Another solid success for USS Maraging Steel

The largest, most powerful solid-fuel rocket motor fired to date (February 27, 1965) generated more than 3 million pounds of thrust—twice the thrust developed by any other rocket motor. The 156-in. diameter motor 100 feet long was tested by Thiokol Chemical Corporation at its Camden County, Georgia, rocket facility as part of the Air Force and National Aeronautics and Space Administration program to study the feasibility of large solid-fueled rocket motors. Some 800,000 pounds of solid propellant were burned in 60 seconds.

This is the fourth successful test firing of 156-in. rocket motors made from 3/8" thick plates of USS Maraging Steel. This 18% Nickel-Cobalt-Molybdenum electric furnace air melted steel series develops useful yield strengths up to 300,000 psi—and it's the toughest steel ever made at these strength levels.

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Lunar Rover Cabin Space Examined

Honeywell engineers conclude three-day simulated sojourns on Moon's surface for NASA-funded study; clothing tested

A SERIES of tests to determine optimum cabin space arrangements for a roving lunar vehicle has been concluded at Honeywell's Systems and Research Division in Minneapolis.

The tests culminated with a three-day simulated venture on the lunar surface by two Honeywell engineers, John Haaland and James Beigle, who started the project in June with three-hour simulations leading to 10-hour tests, followed ultimately by two three-day full "ventures."

The series of experiments has been funded by an $89,400 contract with NASA's Marshall Space Flight Center and the Office of Advanced Research and Technology.

The objectives of the program have been to establish the minimum and optimum volume of cabin space required for two men to function effectively on lunar missions; to determine the provisions for sleeping aboard a lunar roving vehicle, and to establish emergency procedures and to investigate the effectiveness of men operating under

PLYWOOD SIMULATOR of lunar roving vehicle at Honeywell's Systems and Research Div. is 13 ft. long and 7 ft. in diameter. Door at end is entrance to the airlock, one of three sections inside the simulator. Honeywell engineers have just completed two three-day simulated stays on the lunar surface in the test vehicle, which the firm built under contract to NASA's MSFC.

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emergency conditions on the Moon.

Data is now being reduced at Honeywell by the company and NASA.

- **Vehicle dimensions**—The Honeywell engineers began the latest test Sept. 15. The closed, cylindrical plywood cabin, measuring 13 ft. long and 7 ft. in diameter, is located in a small curtained room at Honeywell's Systems and Research Div.

The vehicle is divided into three sections—cockpit, work-sleep and airlock—which have been altered in size for the different phases of the project.

One of the aspects of the study was to determine the effects of different clothing on the performance of the subjects. They wore long underwear most of the time to simulate the shirt-sleeve environment of a pressurized space cabin, but were required to don pressurized space suits and simulate exit from and entry into the lunar "shelter" vehicle.

- **Stress situations**—An emergency situation was simulated in which the astronaut on the lunar surface was said to be unconscious. The performance of the man remaining in the cabin in properly readying his space suit, exiting from the vehicle to aid his companion, and dragging the inert body back into the vehicle was carefully timed. A spacesuited dummy was substituted for the astronaut in distress.

Other lunar surface tasks studied included geological and other scientific experiments such as searching for and examining rocks.

Inside the vehicle, the men performed a schedule of work including driving, navigating, radio communications and maintenance and checkout of their equipment, including pressure suit and backpack. Their ability to don their spacesuits during a cabin pressure leak also was investigated.

Communication with project monitors was made by radio, although the men were allowed to leave the capsule four times a day for personal hygiene and to make one telephone call per day.

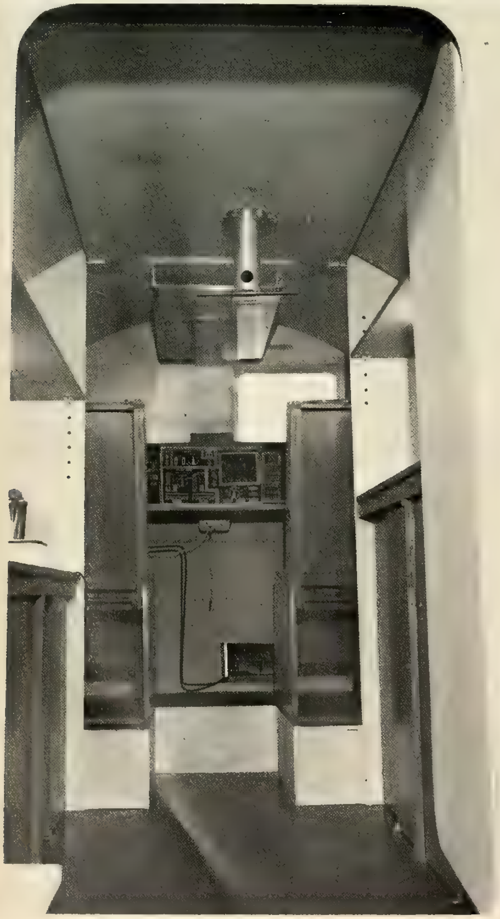
Physiological functions were monitored with a physiograph, recording heart rates, respiration rates, and volumes, blood pressures and body surface temperatures. The men had a large array of sensors attached to their bodies—with extensive monitoring—even to the degree of rest obtained in sleeping in long underwear or pressure suits under various conditions.

The men had four meals each day of special dehydrated food supplied by the Pillsbury Co. One of the two had a partially liquid diet for comparison with the solid food of the other. Both had 2,800 calories each day.

Principal investigator at Honeywell was Dr. Neal M. Burns, with project work director Robert M. Nicholson.

Other study work on lunar roving vehicles is being done at Grumman Aircraft Engineering Corp., also under an MSFC contract, on the visual display, controls and other human factors problems of guiding a vehicle on the lunar surface. ■

LEFT: Cockpit and work-sleep areas of Honeywell simulator in photo taken from airlock. Interior can be modified to make quarters more cramped or more spacious. RIGHT: Engineer takes periscope sighting, one of many tasks performed by subjects during three-day tests to determine space and clothing needs of lunar roving vehicle astronauts.



Aeronutronic Headed for New High

Growth of Shillelagh program paces expansion; Chaparral has big potential; re-entry and space systems work pressed

by Willard E. Wilks

AERONUTRONIC DIVISION of Ford Motor Co.'s Philco Corp. is entering a period of "general expansion" that should push sales and employment to their highest since the company was established nine years ago.

The Viet-Nam war has created some recent unexpected business in the form of $3,000,000 in Army contracts for armor-plating of helicopter seats—work that soon may put the division into the helicopter seat design field.

By far the biggest expansion, however, is occurring in the Army's *Shillelagh* surface-to-surface battlefield missile program, now entering production. This could be the largest missile program ever, in terms of sheer numbers of units. John B. Lawson, division general manager and Philco vice president, told MISSILES AND ROCKETS that *Shillelagh* accounts for more than half of Aeronutronic's sales this year.

The division currently holds a relatively small initial contract, providing $25 million for the first year's production in addition to development and tooling at the Government-owned facility in Lawndale, Calif. A second-year buy is being negotiated. New 1966 funding for *Shillelagh* totals about $61 million, of which Aeronutronic should receive well over half. A second source will be utilized in the *Shillelagh* production program, under which Aeronutronic will receive a contract to aid an additional firm that has yet to be selected.

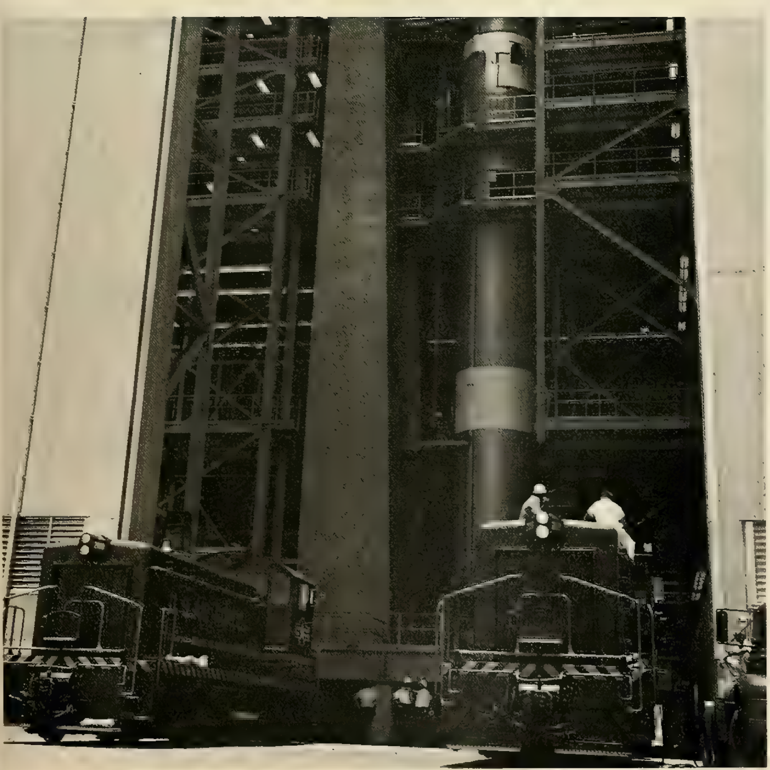
No sales figures are released for individual Ford divisions, but it is known that aerospace firms of similar size and activity have annual sales of $60-80 million.

Lawson reports that since the division started climbing back from a low point in 1962, overall sales volume has increased more than 30%.

Biggest employment growth will occur at the Lawndale facility, which currently employs about 400 and is expected to have a payroll of 1,500 persons a year from now. Current overall employment of 3,250 is an all-time high for the division, exceeding the 1961 peak by about 50%.

Aeronutronic presently is engaged in selective hiring of some 200 engineers, with interviews being conducted at night and during morning hours on Saturday and Sunday. Most of the 200 are being recruited for work in the tactical missile area, including *Shillelagh* and *Chaparral*. An additional employment expansion is expected in the division's second largest business area, re-entry and space systems, currently providing about 30% of sales.

- **Re-entry & space**—Army and the Air Force Ballistic Systems Division are the main customers in this area, which has at least four programs ripening for possible expansion. The division



Third Titan III-C Prepared for Launching

CORE STAGES of third Titan III-C, built by Martin Co., shown ready to be moved by two specially modified diesel locomotives from new 23-story rocket assembly building at Cape Kennedy. When fully assembled, third booster will be first in series to fully utilize Titan III Integrate-Transfer-Launch (ITL) complex. It is due for launch with a payload before the end of this year. Second booster in the series was to go up October 8.

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Automatic Test Systems. Requires experience analyzing design requirements to control product quality.
Structures
Structural elements, thermal protection systems, pressure vessels. Conceive, design components/systems.
Propulsion Design
Set design criteria and evaluate solid and liquid systems.
Advanced Propulsion Systems
Set preliminary design criteria for solid and liquid systems.
Control Systems Engineers
Design, analysis: Thor.
Ground Support Equipment
Design & test ground support equipment. Design electrical systems.
Chemist/Chemical Engineer
Design, develop: Electrochemical, life support devices and pre-treatment techniques for waste fluids.
Chemist—Fuel Cells
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Mathematician
PhD. Help make new, special purpose computers/programs.
Battery Technologists
Design, fabricate, test: High energy density batteries, electrodes, separators, cases, seals, components.

won its way into major re-entry work in 1958, with a penetration aids subsystem for *Atlas F* and certain *Titan* ICBM's. It established its claim as a re-entry system contractor with the *Mobile Medium-Range Ballistic Missile (MMRBM)*, even though that program died. Most of its activities, with the exception of penetration aids, have been of study or R&D nature. Work includes a multimillion-dollar Air Force program to evaluate impact and radar fuze problems for advanced re-entry vehicles (*FATE* and *ABRES*), the Mod 4 payload ejection mechanism for piggyback applications on *Atlas F*, a re-entry measurements program study for BSD, and a classified missile study for the Army.

Space system work includes two efforts which could develop into sizable business—Automated Biological Laboratory (ABL) and a lunar penetrometer for NASA. The division is studying and establishing requirements and preliminary design for ABL, which may, as part of Project *Voyager*, be landed on Mars to determine the possibility of life. The penetrometer is being developed for use by lunar astronauts to evaluate surface hardness before landing. ABL could produce sales of tens of millions of dollars.

There is also classified Navy work in the space area.

• **Weapons mainstay**—Main portion of the division's work, however, is in tactical systems, Lawson noted. He estimated that "We are involved in weapons and related fields for 80 to 85% of our business."

In addition to *Shillelagh*, this includes another major program, the aforementioned *Chaparral*, an adaptation of Philco's *Sidewinder* air-to-air mission to an interim antiaircraft role for the Army in forward battle areas. *Chaparral* consists of the *Sidewinder 1-C* emplaced on a modified M-45 machine gun mount on an M-548 full-tracked cargo vehicle.

Chaparral, undertaken as a result of loss of confidence in *Mauler*, could also see major growth. Aeronutronic began the program in February with a systems contract, and is now in the engineering phase. It is believed likely that a decision will be made to use *Chaparral* in place of *Mauler*, with the missile being Government-furnished equipment and the contractor supplying necessary modifications and adaptations. Because of the time element, Aeronutronic probably would receive the first procurement contract.

A further possibility, based on the advantages of availability and low development cost, is a *Sea Chaparral*.

• **Reconnaissance**—Promise of growth is also seen in the division's reconnaissance and intelligence product area, Lawson reports, with "small but very significant contracts with which we are beginning to establish ourselves as a contractor in reconnaissance-mapping." Work here includes an experimental program to determine the practicality of taking long-range photographs of areas at an oblique angle, making possible aerial reconnaissance of areas without over-flight.

• **Propulsion**—Two major propulsion products are the hot-gas valves developed for *Blue Scout*, *Shillelagh* and *Minuteman*—all operating on the same principle—and rocket motor cases for *Shillelagh*. The division is working with the Naval Ordnance Laboratory on a hot-gas valve program for a top-secret missile project.

• **Utilizing talents**—"Looking to the future, Aeronutronic sees itself in a good position for growth in the areas we are in today," Lawson says. "In space, we looked at the market and concluded that all the big programs had been placed, so we are looking at what we can do beyond *Apollo*, such as ABL."

A development planning spokesman makes these observations:

"We see growth in the smaller missile systems, tactical missiles, a breakout in the 5-20-mi.-range class of air-to-surface missiles, successors to such missiles as *Shillelagh* and *Chaparral*. The military would like to operate at night, in the fog, and with greater mobility.

"Sooner or later, DOD will defend the *MMRBM* concept for U.S. use, not NATO. The Russians have a portable, shippable missile now in the range gap between *Pershing* and *Polaris*.

"There are two ways we think we can get into space vehicles. One is our re-entry work, applying that to entering other atmospheres. The other is taking off from the combination of our *Ranger* program experience in hard-landing instruments, and our ABL instrument work, to achieve unmanned landing vehicles for the Moon beyond *Apollo* and for Mars. In both defense and space, the kind of things we are looking for are those which utilize the talents we've got."

• **Studying nature**—In its in-house research, the division is restricting its efforts mainly to biosciences. Dr. Robert E. Kay reported:

"We are looking at the mechanisms nature uses to solve problems. Nature has developed systems and solved problems of interest in the overall defense area. We are primarily inspecting structures in which we hope to get information on biological systems which can be used to construct physical or chemical analogues for defense and related systems. Some areas are information processing, specific chemical selectivity, and improved ways of measuring physical phenomena." ■

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Douglas Studying Oil Bath Weightlessness

A NEW APPROACH to the problems of simulating the effects of weightlessness on the human body has been tested at Douglas Missile & Space Systems Div.

While there have been many studies in which water immersion has been used as a substitute for actual weightlessness, the recent Douglas test is believed to be the first using silicone oil as the immersion fluid. The results of a 10-day immersion in silicone oil were compared with a 10-day period of bed-rest on the same subjects.

The work was done under a three-month study contract from NASA's Manned Spacecraft Center.

The subjects are the same students from colleges in southern California who have participated in other tests at Douglas, such as the centrifuge experiment last year, in which Douglas reported that periodic rotation on a short-radius centrifuge seemed to counteract the effects of bed-rest weightlessness.

- **Training**—During the recent tests, the 12 subjects were divided into groups of three. Two groups started first, training for the two types of weightlessness simulation. Preparations for each phase—oil or bed-rest—included medical tests and performance measurements to establish baselines, and a regimen of bicycle ergometer and treadmill exercises for physical conditioning.

The first two groups then went into either the oil bath or bed-rest phase, while the other two groups were conditioning. After the completion of the immersion or bed-rest test, each group was allowed a six-week recovery period before starting on the alternate assignment. This period was chosen as one in which total physical recovery from any effects of the weightlessness simulation by either method would occur.

After each 10-day simulation, the subjects were checked carefully for cardiovascular deconditioning and other possible physical effects. The post-simulation examination also included a ride on a centrifuge to test their tolerance to rotations creating up to eight times the force of gravity, such as that which would be experienced in re-entry.

- **Oil bath**—The three subjects in the oil phase were immersed up to their chins, while in a horizontal position. This position, whether on their backs or stomachs, was maintained so that the cardiovascular system would be subject to the same gravity in all portions of the body. With their heads out of the oil, the men were able to read and have other entertainment such as television and drama.

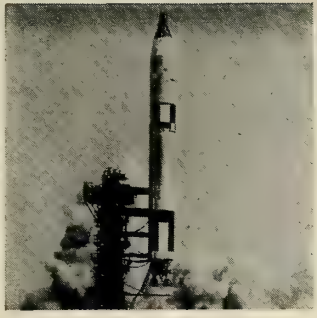
The silicone oil, the same grade as is used in cosmetic preparations, was continually circulated in a system that filtered and deodorized the fluid. Since it is inert and inhibits the growth of bacteria, there is no problem of skin infection or maceration as would be the case with water immersion. Temperature was kept at near body temperature. The subjects were on a 2,100-calorie-per-day diet.

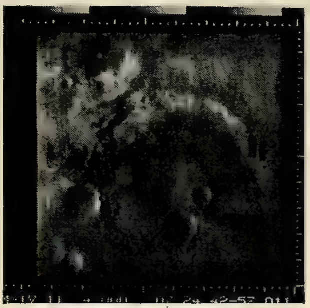
Douglas scientists have run the full gamut of weightlessness simulation, having also conducted water-immersion simulations. In previous experiments, the company attempted to discover the problems of operating in the weightlessness environment through immersion in a 150,000-gal. water tank that was 50 ft. long, 20 ft. wide and 20 ft. deep. Using space station mockups immersed in the tank, rubber-suited crewmen attempted to perform space-station-type tasks.

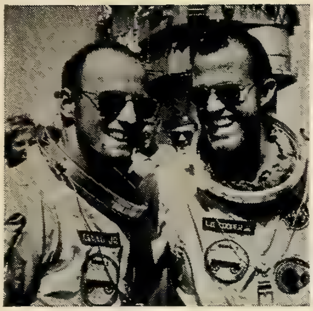
The company also has been looking at a device for research on the cardiovascular system in a manned orbiting space station. The device would have the same function as does the tilt table on Earth.

To accomplish this, Douglas scientists have designed a negative-pressure boot, a large cylinder, which is applied to the lower half of the subject's body. This contains a reduced pressure of 40 to 50 mm mercury. Even in the prone position, the boot produces the same effect on the lower part of the body as does gravity. Thus, the ability of the astronaut's cardiovascular system to withstand normal gravity upon return to Earth could be measured while he was still weightless, for research purposes and to determine whether conditioning for re-entry is necessary. ■

Circle No. 11 on Subscriber Service Card







what's next nasa?

MISSILES AND ROCKETS asked this probing question "What's Next NASA?" And on November 29, 1965, MISSILES AND ROCKETS will publish its Fifth Annual NASA Issue with answers to this question as well as an authoritative examination of the National Aeronautics and Space Administration's current and future projects and facilities.

After a year of spectacular achievement, including Astronaut White's record extravehicular space walk and Gemini 5's record 191 hours in space, NASA is looking ahead to its new space programs. Special emphasis is placed in this issue on the Apollo Extension Systems (AES) which have an estimated total cost of over $1 billion, and project Voyager, which will explore Mars, Venus and other planets.

This special issue will also explore NASA's plans for other new projects as the U.S. space program begins its swing away from the exploration of the Moon to the vaster and more challenging mission of probing the planets.

MISSILES AND ROCKETS provides the recognized and authoritative route to reach the men who will be making the research, design, engineering and procurement decisions in these new multibillion-dollar programs.

BONUS CIRCULATION: By request, the fifth annual NASA issue of MISSILES AND ROCKETS will provide 5,000 bonus circulation to the decision-makers in Government, the Atomic Energy Commission and the National Aeronautics and Space Administration.

Publication Date: November 29, 1965 Closing Date: November 15, 1965

American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington, D.C. 20005

missiles and rockets
THE WEEKLY OF ADVANCED TECHNOLOGY

M/R

Recorders Slash Time Base Error

Reduction in skewing, new capstan system design credited with refining Ampex line intended for reconnaissance, telemetry

by Robert Lindsey

REDWOOD CITY, CALIF.—Ampex Corp. this month will deliver the first models of a new family of instrumentation tape recorders that have significant state-of-the-art improvements in accuracy and capacity.

Designed for reconnaissance and telemetry applications, the Ampex 1600 series of ground, sea and airborne recorders has a bandwidth of 2.0 mc. and achieves a 100-fold improvement in time base stability—the major yardstick of recorder accuracy—over present recorders, according to Ampex.

The series includes the FR-1600 for ground station and laboratory use, the AR-1600 for airborne applications and the PR-1600 for field, van and shipboard recording.

Late last month, Ampex had order for 28 models in the 1600 series—2 airborne systems and 10 of the larg ground-based recorders. All are bein delivered for classified military programs.

G. S. Shoaf, 1600 series produc manager, says Ampex is offering th

LEFT: Model FR-1600 instrumentation recorder is said to offer more than a 100 to 1 improvement in time base accuracy over systems presently available. RIGHT: Airborne part of series, the AR-1600, is described by Ampex as the only airborne re corder that can both accommodate 14-in. reels and provid simultaneous 14-track record and reproduce capability.

recorder at prices comparable to the 1.5-mc Ampex 1400, a standard recorder in many Department of Defense and NASA installations.

- **Time base error cut**—The major advance of the new recorders is reduction of time base error (TBE).

Time base stability is a term that refers to the exactness with which the time interval between two or more events is reproduced on any of the 14 tracks on the tape.

While the Ampex 1400 series and other comparable recorders have a time base error of 250 microseconds, the FR-1600 has a TBE of 0.5 microseconds and the portable and airborne systems have a TBE of 2 microseconds.

The improvement is particularly significant for aerospace telemetry applications in which, for example, it may be essential to know precisely the time relationship of several events, such as subtle changes in temperatures, vibrations or other phenomena.

Chief causes for time base error are cyclical error of the capstan or other rotating elements, caused by tiny flaws in machining; "skewing," the tape's crossing of the capstan at a slight angle instead of in a straight line; and elasticity of the tape, causing miniscule variations in the speed at which it passes the capstan.

- **Refinements**—Shoaf says the dramatic reduction in TBE resulted essentially from two design improvements:

To all but eliminate skewing, Ampex engineers designed vacuum chutes immediately before and after the capstan, providing a frictionless, cushioned path for the tape so that it glides accurately onto the capstan and is held firmly in place by the vacuum.

Secondly, a unique, servo-driven capstan system is used (the single capstan is the only moving part in the system, besides the reels). Pinch rollers and other conventional rotating elements have been eliminated in the drive to reduce opportunity for extraneous perturbations.

During recording, a 200-kc reference tone is placed on the tape. During playback, if the tone is not played back at the same frequency as it was recorded, a servo is activated automatically and drives the capstan at the proper speed.

All members of the 1600 family are designed to operate with one-inch and half-inch tape at speeds from 120 ips to 3¾ ips.

- **Interchangeability**—Because the three systems were developed as an integrated family, tape recorded on one model is interchangeable on all models, and signal integrity is maintained when data is acquired under various conditions.

With 2-mc bandwidth, the recorders increase capacity of the Ampex 1400 series by one-third. Although there are competitive 2-mc laboratory-tracking station recorders, Ampex claims it is the first to market a 2-mc airborne recorder.

Weighing 125 lbs., the AR-1600 has been qualified to 70,000 ft., uses 14-in. reels and offers 14 track record/playback capability. The 14-in. reels provide 15 min. of recording at 120 ips. The airborne unit, only 2 ft. high by 1½ ft. wide, incorporates an unusual helical wind. Both reels are mounted on the same axle, and the tape moves from one to the other by spiraling along a mandrel projecting at an angle at one end of the case. The 800-lb. FR-1600 laboratory model is the first recorder in its class to accommodate 16-in. reels, providing 20 min. of recording at 120 ips. ■

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space electronics

Space Life Detection Seen Enhanced

Tests conducted by GE indicate use of IR sensors, mass spectrometers may offer advantages over present methods

by Heather M. David

EXPERIMENTS at General Electric's Missile and Space Division indicate that a new technique using infrared sensors and mass spectrometers may offer advantages over other currently investigated methods of detecting extraterrestrial life.

The technique, as suggested by J. J. Konikoff, does not depend upon a preconceived notion of what life may be like, and it would make it possible to investigate micro-organisms in their natural environment and substrate.

GE also surveyed existing instrumentation to see whether the technique is feasible. It tested Barnes Engineering Co.'s Infrared Medical Camera, and the GE Partial Pressure Analyzer, which is a mass spectrometer for ultra-high-vacuum analysis, and concluded that presently available instrumentation could be adapted to a flight system.

The instrumentation tested by GE also appears to be capable of heat sterilization, a requirement which must be met by all experiments headed for other planetary bodies. It has been the comment of scientists studying the problem of sterilizing space probes that the experiments on board to detect life may be the hardest to make sterilizable.

Konikoff pointed out in a paper given at the International Astronautical Federation in Athens, Greece, that all the techniques now under study or development are based upon certain assumptions. They assume, first, that what life might be found will metabolize the kinds of materials which are well known on Earth. Secondly, they assume that the organisms will take up specific gases and evolve others, as do Earth types. Another assumption, Konikoff said, is based upon the universality of the abundance of macromolecules in living organisms. While it may be reasonable to assume that life may be similar to something in terrestrial experience, he points out, results could be produced that might be wholly untrue.

- **Other drawbacks**—Another difficulty with some of the current devices is that no single device gives information on all the characteristics which may be considered as defining life. These, Konikoff said, are reproduction, growth, metabolism and organization.

The Wolf Trap and Vidicon Microscopy examine two each—the former the first two, and the latter the last two. Gulliver and the Multivator both are designed to give data on metabolism, while the J Band, the Optical Rotation device, the mass spectrometer and the UV spectrophotometer inform on organization. The GE technique would report on three—reproduction, growth and metabolism.

Another problem is that several—Wolf Trap, Gulliver and Multivator—require the addition of an aqueous medium, which Konikoff says could well drown any viable organism, since Mars has little if any water of its own.

• **GE concept**—The concept GE has worked out is based upon the fact that metabolizing organisms have a constant energy exchange in which heat is produced. Konikoff suggests that they may be considered heat engines in this respect. As a living organism ingests food and converts it, a finite ΔT will occur between the organism and its environment.

In addition, the conversion of fuel to energy is most likely to occur through an oxidation or equivalent process of gas exchange. The gas exchange process is always shown in the chemistry of living organisms, in an equation of state.

Thus, he concludes, if it were found that a positive temperature differential existed along with evidence of a gas exchange it could be inferred that metabolizing organisms were present.

The method at GE calls for the introduction of a sample of soil or other material into a previously sterilized container which is much larger than the sample, leaving a "head" of indigenous atmosphere above the sample. By leaving intact the natural habitat of any organisms which might exist there, they should continue to metabolize.

A sensitive infrared sensor would then scan across the sample of the surface, recording any slight and consistent change in color. Such hot spots would suggest metabolizing organisms.

To enhance the confidence level of the validity of the technique, continuous measurement of a selected component of the gas composition would be made, based upon prior knowledge of the gas constituents of the planetary atmosphere. This constituent could be checked by monitoring partial pressure. Any change would also imply viable organisms, Konikoff said.

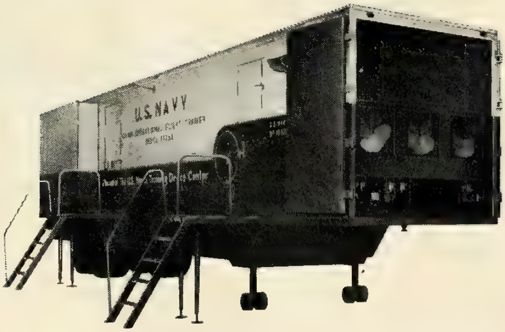
• **Instrumentation**—The Barnes IR Camera used for the experiment contains 60,000 discrete temperature measurements, and has a sensitivity of 0.05°C. Scan rate for the experiment was increased from 12 minutes to four minutes, and a potential exists for decreasing it to two minutes. The GE Partial Pressure Analyzer has a slow or fast scan rate and is capable of operating at partial pressures of 10^{-4} torr, making it suitable for operating on Mars.

Konikoff pointed out that the reliability of both devices should be enhanced because of the low or practically non-existent water supply on Mars, since water would interfere with accurate determination.

Several experiments were carried out to test the theory. A sample of shoreline river sludge was taken from the Schuylkill River near GE's Valley Forge plant. One portion was autoclaved, and a gas analysis (ratio of nitrogen and carbon dioxide) made of the sterile sample. A raw sample was then tested in the sampling system of the Partial Pressure Analyzer, and a reading showed that there was high activity until after 96 hours in which the number of organisms apparently decreased as the natural nutrient supply became exhausted. Complete culture death apparently occurred after 130 hours, and the sample curve approached the autoclaved sample value.

(Continued on p. 44)

TRAILERS FOR THE SPACE AGE by DORSEY



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FULLY AIR CONDITIONED ELECTRONICS VAN. This trailer houses calibration and instrumentation equipment for the Apollo Program, Mississippi Test Site Operations, Michoud, La.

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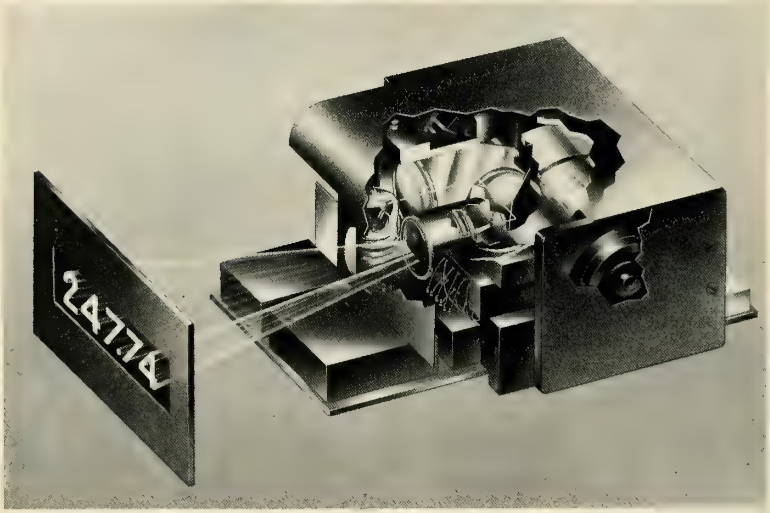
Microscope examination before the experiment showed that there was a rich population of bacteria, which were dead at the end of the experiment, bearing out the gas analysis.

Two similar samples were also tested on the Barnes IR sensor at Barnes' company plant in Stamford, Conn. In this, clumps of sterile sludge and sterile stones were placed in the sludge, along with some actively growing bacterial culture. Thermograms taken a short while later showed clearly the sterile areas and the spread of the growing bacteria.

Another experiment was conducted on a green bean, which resulted in an accurate thermogram picture of the existing conditions of the sample Konikoff said.

In summary, Konikoff pointed ou that the technique would minimize design problems—since no pre-store nutrients, no tagged elements or othe materials would have to be carried o the space vehicle to conduct th experiment.

space electronics



New Product of the Week: Digital Display Subsystem

Two models of the Datastrobe digital display subsystem have been announced by Raytheon Co.'s Components Div. They are the five-digit display Model EM 1-5D and the six-digit display Model EM 1-6D. Both subsystems include floating decimal points.

The units use a stroboscopic technique to project multi-character presentation and feature an integral motor and rotating drum. Time-sharing of the strobe light and a single decoder-comparator circuit for six-character columns and floating decimal point reduces the number of components required, the firm pointed out. Both models connect directly to 4-bit BCD input of 2v and 1 milliampere per bit. A complete six-character number takes 22 millisecs to form.

The subsystems are designed for use with computers, digital test equipment, radar, digital controls and marine and airborne navigation systems.

Circle No. 151 on Subscriber Service Card

Circuit Fault Finder

A portable device to help locate an open fault in paired communications cable up to 20 mi. long in one reading is being produced by Hewlett-Packard Co.'s Delcon Div.

The Model 4910A open fault locator uses an automatic charge sampling technique to provide a reading directly in feet. The solid-state unit may be set for variations in cable capacity caused by line usage, atmospheric temperature and low-capacity carrier circuits. It has five linear-reading distance scales: 100, 200, 1,000, 10,000 and 100,000 ft.

To locate an open, the operator first checks for voltage and resistance. Next, he sets "D" Factor for actual conductor capacity. A distance reading is obtained and a chart permanently etched on the instrument case gives correction factors for build-out capacitors.

Circle No. 152 on Subscriber Service Card

Transistor Amplifiers

A line of transistor amplifiers, designed for extremely low noise figure in the UHF and VHF ranges, has been announced by Micro State Electronics Corp.

Typical of the series is the Model TQN-2251-2 dual transistor amplifier assembly. The unit operates over a range of 225 to 235 mc with a gain of 25 db and a maximum noise figure of 2 db.

The assembly provides more than 60 db of rejection at 210 and 250 mc. Power source is 115v, 60 cycle lines.

Circle No. 153 on Subscriber Service Card

Spectrophotometer

A grating ultraviolet spectrophotometer for transmittance and absorbance measurements in the 190 to 700-mu wavelength range has been announced by Beckman Instruments, Inc. The range may be extended to 800 mu with a red sensitive photomultiplier.

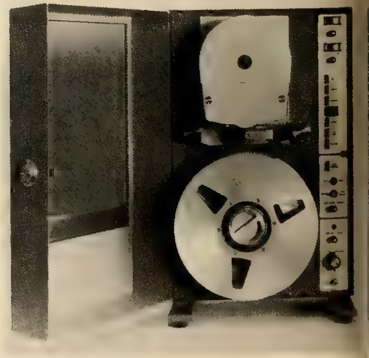
The Model DB-G incorporates a precision grating in place of the standard prism for a resolution of 0.2 mu at all wavelengths. Accuracy is better than 0.5 mu. The unit also features an automatic filter changer to automatically select the correct filter for the region of the spectrum being measured.

Circle No. 154 on Subscriber Service Card

Portable Recorder

A portable recorder that combines broadband instrumentation functions with video recording is being produced by Precision Instrument Co.

The PI-7100 has a 1.5-mc sine wave



ithin the next two years, an American astronaut will leave is orbiting Gemini spacecraft and perform unprecedented aneuvers in space completely free and untethered.

hat an astronaut will be able to accomplish such a feat is the irect result of space maneuvering programs launched by the ir Force and the Astronautics Division of LTV Aerospace orporation in 1959.

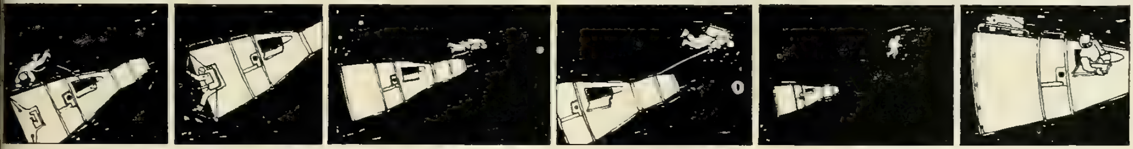
he results of studies and experimentation has produced an MU (Astronaut Maneuvering Unit) which literally converts astronaut in a pressure suit into a one-man spacecraft for erforming useful tasks in space. The first space-type AMU ready has been delivered — 20 days ahead of schedule. At ast six others will follow soon.

To be used initially as Air Force Gemini Experiment D-12, this AMU provides the Air Force with space maneuvering capabilities not only for Gemini, but also for future space programs.

At present, at least two flights are planned with the AMU during the Air Force's Experiment D-12. On the first mission, the astronaut will use a short tether. On the second, he will detach his tether and become the first astronaut in the nation — perhaps the world — to maneuver completely free and untethered.

These initial AMU flight excursions will be experiments in extra-vehicular maneuvering operations. The Air Force and LTV are now looking well beyond these initial research flights toward important space assignments for both manned and unmanned space maneuvering systems.

xperiment D-12 mission profile includes astronaut egressing rom capsule on short tether, proceeding to adapter section, onning AMU and moving to nose of capsule where he performs checkout maneuvers, releases tether and begins flight sequence. Later returning to spacecraft, he fastens his back pack to adapter surface, re-enters Gemini. Mission complete.



untethered and free

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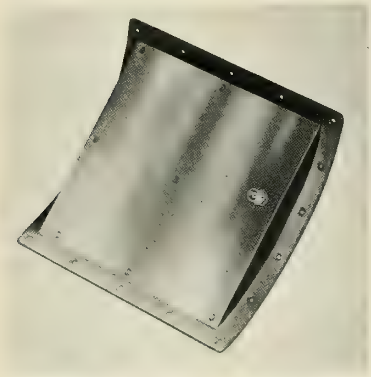
bandwidth and 3.5-mc bandwidth for television or pulse signal analysis. Video or instrumentation data can be reproduced in forward or reverse playback with presentation at continuously variable speeds from 0 to 16 ips. The unit has two switchable recording speeds: 7.5 and 8.46 ips. Operational temperature is 40° to 120°F.

Circle No. 155 on Subscriber Service Card

Telemetry Antenna



A shallow-cavity telemetry antenna approximately 15 in. in diameter for use in missiles and rockets has been announced by Dorne and Margolin, Inc.

The DM AK18 is a flush-mounted stainless steel unit weighing 2 lbs. VSWR is 1.5:1 over any 1-mc band; efficiency is 90%. Polarization is linear.

Circle No. 156 on Subscriber Service Card

Magnetostrictive Filters

A line of magnetostrictive filters, designed for spectrum analysis, encoding and decoding, stable oscillator and other applications, is being marketed by Acton Laboratories, Inc.

The filters are available as single units or arrays with frequency values from 15 to 400 kc. Bandwidths are available from 1 to 8 cps at 400 kc, and 10 to 150 cps. Input and output impedances range from 15 to 2,800 ohms.

Accuracy of the resonant frequency is standards at ±10% of the bandwidth; ±5% is available. Stability is 1 part per million from 5° to 65°C.

Circle No. 157 on Subscriber Service Card

Differential Potentiometer

Humphrey, Inc., is marketing a differential potentiometer, the Model CP-34. The device is designed for servo systems applications and has a resistance of 10,000 ohms. It features electrical travel of 357 degrees, ±2 degrees, and a continuous mechanical rotation of both shafts.

The wiper shaft has a torque characteristic of 1 gram-centimeter. The other shaft carries the winding and slip rings and requires approximately 200 gram-centimeters of driving torque.

Circle No. 158 on Subscriber Service Card

Environmental System

An environmental system with multiple test bay temperature chambers for continuous checkout or sorting of components has been announced by Delta Design, Inc.

Individually controlled chambers have a range of 0° to 50°F and can be controlled within ±⅛°C. Each may be individually programmed and temperature setting of one chamber has no effect on the other chambers.

Individual chambers can be equipped with appropriate mounting devices and access ports for specific applications.

Circle No. 159 on Subscriber Service Card

Distortion Analyzer

A variable stop pulse length telegraph distortion analyzer, the DAS-10, is available from Radiation, Inc.

The solid-state instrument has 12 operating speeds ranging from 10 to 10,000 bauds and a floating input for higher common-mode voltages. Distortion accuracy is ±2%. The instrument can be adjusted to stop pulse widths from 1.00 to 2.00 units in 0.01-bit increments.

Circuits are encapsulated into 10 individual plug-in modules, reducing spare requirements to 10 units having an average mean-time-between-failures in excess of 56,000 hrs. The device has a 128-character message including standard alpha-numeric and ASCII formats.

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Univac Defense System

Univac offers a comprehensiv line of data-processing equipmen and computers for virtually an application. For example:

Univac Peripheral Equipment

- **1532 Input/Output Console**

Capability:

Designed for Rugged Environments
Page Printer & Keyboard
Paper Tape Reader — 300 cps;
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Physical Characteristics:

Size: 57" high (with printer) x
22.5" wide x 24.5" deep
Weight: 385 pounds
Cooling: Air — 340 cfm

Functional Capabilities:

Printer & Keyboard: 7-bit ASCII Code
Paper Tape Reader & Punch: 5-8 levels
(11/16", 7/8" or 1" tapes)
On-Line with all UNIVAC Military Computer
Off-Line for tape prep, tape-to-print,
or tape-to-tape

- **1540/1541 Magnetic Tape Uni**

Mil Spec Design (Mil-E-16400)

Control Unit:

Handles two to eight transports
Duplexer for operation with two computers
Compatible with all UNIVAC Military
Computers

Tape:

Width: ½ inch
Type: "A" wound — mylar base
Length: 3600 feet max.
Thickness: 1.0 or 1.5 mil
Reels: 10½", compatible hub
Tape Markers: Load Point and End of
Tape reflection markers

Recording Techniques:

NRZ (change-on-one)
Seven Tracks (6 data, 1 parity)
Density — 200, 555.5, or 800 bpi
(program controlled)
Record Length — variable
Parity — Lateral and Longitudinal
Selective Write
Backread

Speed:

1540 Tape Transport — 120 ips
(240 ips rewind) 96 KC transfer rate max
1541 Tape Transport — 150 ips
(225 ips rewind) 120 KC transfer rate max

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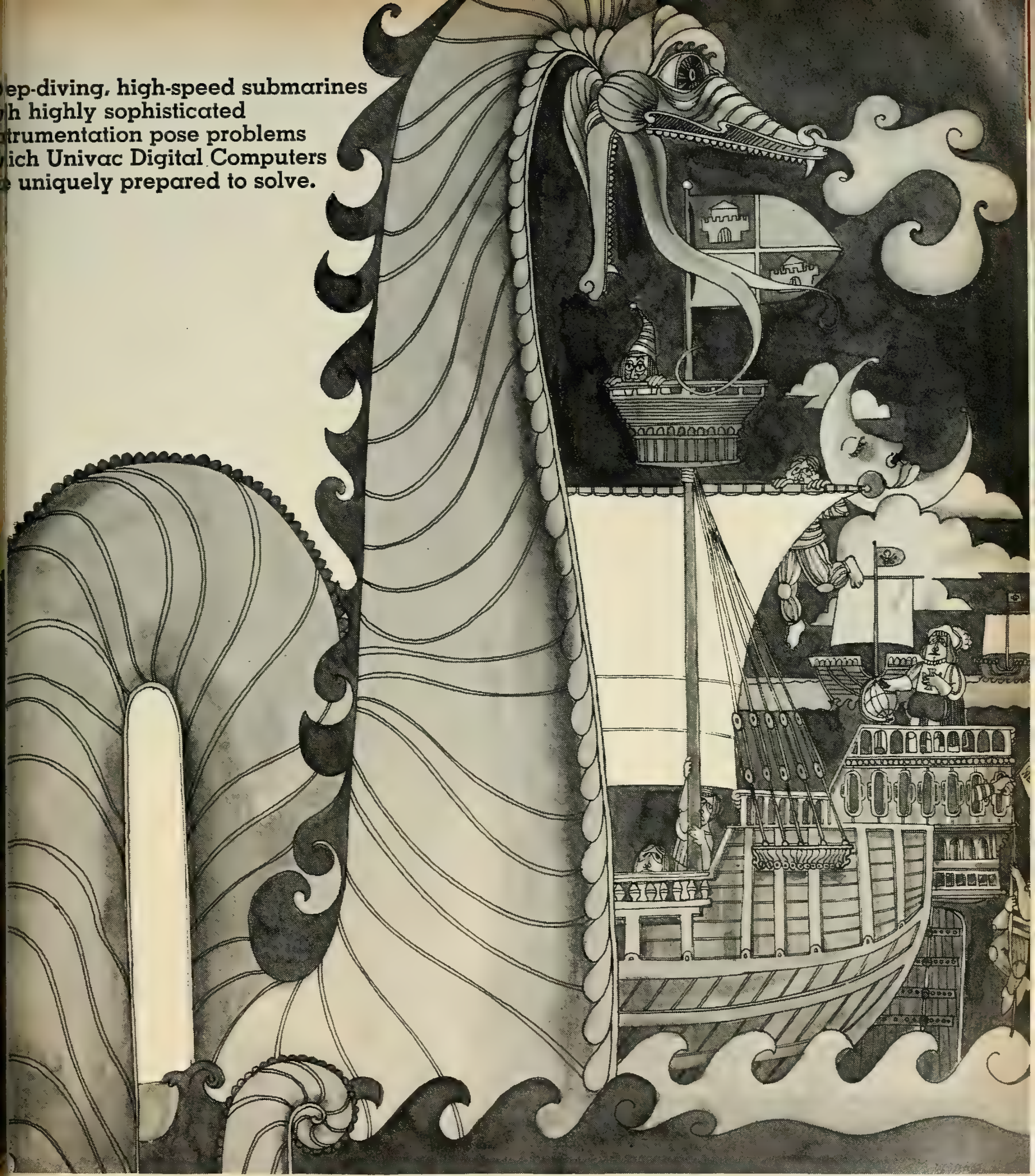

Sighted sub, sank same"—those were the ays.

Today subs are faster, run deeper and an stay under longer. Sub commanders re foxier. Evasion tactics are subtler. ven the water conspires against us. It's ore crowded. (The fish, random currents, mperature and pressure pockets were ways there—but now we pick them up.)

To answer these challenges, modern SW depends more and more on delicate ensory apparatus. Each ASW vehicle ust correlate its own data and also try to correlate its results with the data of other ASW craft in the area.

It's a staggering amount of data. And only a ruggedized, high-speed, high-capacity, highly versatile digital computer can handle it.

That's what the Navy's been using in its top-priority A-NEW Program. The CP-823/U. Alias, The Univac 1830. (In fact, our involvement in the A-NEW Program extends to full responsibility for equipment and programs.)

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- Acoustic properties of the ocean
- Three-dimensional tracking systems
- Military missions in space
- Building on the ocean floor
- Digital control system techniques
- Miniaturized telemetry development
- Nuclear explosion warning systems
- Computerizing recruit assignments
- Testing the Poseidon Weapon System
- Supersonic water entry shock environment
- Advanced replenishment-at-sea methods
- Computerizing information storage/retrieval

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The Industry Week

Mergers and Acquisitions

Northrop Corp., Beverly Hills, Calif., has agreed in principle to acquire the Amcel Propulsion Co., a division of Celanese Corp. of America. Amcel develops and makes chemicals, explosives, ordnance and rocket propulsion devices for the Dept. of Defense and NASA at its Asheville, N.C., plant. Amcel, in addition to its weapons and rockets work, performs engineering and systems design and produces control devices for the capital equipment market. . . . *Varian Associates, Palo Alto, Calif., has completed negotiations to acquire Wilkens Instrument and Research, Inc., Walnut Creek, Calif. Wilkens is engaged in research, development, production, sales and service of gas chromatographs. The acquisition will be operated by its present management as a Varian subsidiary.* . . . Solitron Devices, Inc., Tappan, N.Y., has acquired the Integrated Circuits Laboratory of Kearfott Div. of General Precision, Inc., Little Falls, N.J. Solitron will also obtain the rights to Kearfott's U.S. patent applications related to integrated circuits. . . . *Prodelin, Inc., Hightstown, N.J., designers and manufacturers of antenna and transmission line systems, has acquired the designs and products of Navigaides, Inc., as part of a long-range expansion program in oceanography. Navigaides will operate as the Navigaides Div. of Prodelin and will have the primary responsibility of continuing development and manufacture of Para-Buoy telemetering platforms for service in surface and sub-surface moored applications or as a towed instrumented vehicle.* . . . Lear Siegler has agreed to acquire the assets of Mammoth Industries, Inc., of Minneapolis. Mammoth makes commercial and industrial air conditioning and heating equipment. . . . *Stockholders of the GCA Corp., Boston, have approved a proposal to acquire Precision Scientific Co. of Chicago, a manufacturer of laboratory apparatus and analytical instruments and aerospace and defense R&D firm. Purchase price is said to be approximately $10,170,000 and the merger is expected to become effective before Oct. 31.* . . . Stockholders of Fairchild Hiller Corp. and Republic Aviation Corp. in separate meetings held Sept. 29 approved the purchase by Fairchild Hiller of most operating assets of Republic for approximately $44.4 million (M/R, Aug. 23, p. 41). The payment will include some $17.6 million in cash and up to 1,459,457 shares of Fairchild Hiller common, one-half share for each share of Republic outstanding.

New Activities

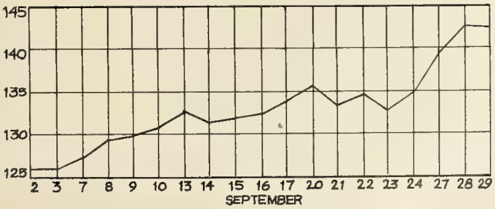
Trans World Airlines, Inc., Holmes and Narver, Inc., and Bendix Field Engineering Corp. have formed an organizational team to perform management, maintenance, logistics and operations work under contract to private and governmental agencies. The team has already submitted a technical proposal to provide logistics and base support services at the Kwajalein test site for the *Nike-X* project office of the Army Materiel Command. . . . *Terra Corp. has been formed in Albuquerque, N.M., to design and manufacture triode strip transmission line microwave oscillators. Other product lines are planned, including plate- and grid-pulsed continuous-wave and continuous-wave/frequency-modulated oscillators, and solid-state strip transmission line L- and S-band oscillators.* . . . Ceramagnetics, Inc., has been formed in Clifton, N.J., to develop and produce a full range of precision ferrite components and devices. The company is founded on assets, technologies, patent rights and personnel recently acquired from the ferrite operations of Kearfott Div. of General Precision, Inc. . . . *Itek Corp., Lexington, Mass., has formed a Microphotography Section, enlarging and consolidating the specialized production of micro-images.*

Facility Expansions

Brown Engineering Co., Huntsville, Ala., has announced plans to build a $1-million plant in Lewisburg, Tenn. The 41,500-sq.-ft. plant will make specialized electronic equipment for space, defense and industrial applications and will employ some 200 persons. . . . *Massachusetts Institute of Technology has dedicated a new $6-million interdepartmental Center for Materials Science and Engineering on its Cambridge campus. The building provides 150,000 sq. ft. of space for work in such areas as preparation, purification and evaluation of metals, insulators, semiconductors and ceramics. Research to be conducted in the building will be concerned primarily with fundamental studies of the structure and properties of many kinds of materials important to contemporary science and technology.*

Missile/Space Stock Index

Several large aircraft orders helped to elevate Boeing stock to unprecedented heights, taking it well over 100, representing a more than 25% gain in its price since the first of September. Rumors on the C5A aircraft announcement continued to spark surges in the prices of contenders Lockheed, Douglas and Boeing. In addition, a number of other representative aerospace stocks set new 1965 records as interest in missile/space stocks remained high. The Missile/Space Stock Index remained over the point which signified a ⅓ gain since the first of the year, and topped 140 for the first time.



100 = CLOSING PRICES OF 19 REPRESENTATIVE AEROSPACE FIRMS DEC. 31, 1964
STOCK PRICES FURNISHED BY MERRILL LYNCH, PIERCE, FENNER AND SMITH

AWARDS

AIR FORCE

$18,975,000—**Hercules Powder Co.,** Salt Lake County, Utah, for production of solid rocket motors for *Minuteman II* at its Bacchus Plant.

$8,150,000—**Mitre Corp.,** Bedford Mass., for research and development work on command and control systems.

$6,500,000—**Boeing Co.,** Andrews AFB, Md., to develop a highly reliable, low-cost upper stage for placing small and medium-size payloads in orbit.

$5,000,000—**Marquardt Corp.,** for evaluation of Scramjet propulsion under actual flight conditions at hypersonic speeds.

$3,000,000—**Philco Corp.,** Palo Alto, Calif., for continued work on a satellite network.

$1,917,554—**Cryo-Sonics, Inc.,** Torrance, Calif., for modification of liquid oxygen-nitrogen mobile generating plants.

$1,920,479—**Avco Corp.,** Stratford, Conn., for *Mark II-A* re-entry vehicles.

$1,500,000—**Sylvania Electric Products, Inc.,** Buffalo, N.Y., for continued volume production one-man radio command posts.

$853,000—**Hughes Aircraft Co.,** Culver City, Calif., for an advanced tactical air-to-surface missile guidance technology program.

$500,000—**Philco Corp.'s** Western Development Laboratories Div., Palo Alto, Calif., for a range systems engineering study of the USAF Western Test Range.

$478,000—**Douglas Aircraft Co., Inc.,** Santa Monica, Calif., to investigate effects on vehicle performance of space vehicle engine restarting, deep throttling and long-term storage of liquid fluorine and liquid hydrogen propellants.

$350,000—**North American Aviation, Inc.,** Los Angeles, Calif., for a study of a CX-6 Assault Transport.

$318,925—**Radio Corp. of America,** Burlington, Mass., for a classified program with the Aerospace Systems Div., Air Force Systems Command.

$190,214—**Martin Co.,** Denver, Colo., for advanced studies into techniques for explosive forming of metal structures as large as 50 ft. in diameter.

$190,058—**Ets-Hokin Corp.,** Electrical Manufacturing and Service Co., for *Shrike* missile containers.

$84,000—**Sylvania Electric Products, Inc.,** Mountain View, Calif., for continued research on a new technique that converts dozens of laser light frequencies into a narrow single-frequency beam capable of transmitting signals more clearly than existing methods.

$46,040—**Stanford University,** Stanford, Calif., for feasibility demonstration of measurement for particle velocity in two-phase flow by means of the doppler shift in incident laser light.

ARMY

$228,500,000—**Western Electric Co.,** New York, for continued development and testing of the *Nike-X* antimissile-missile system.

$13,795,000—**American Machine & Foundry Co.,** Brooklyn Div., to manufacture 750-lb. bombs and related equipment.

$12,405,408—**Western Electric Co.,** New York, for preproduction engineering and planning work on the *Nike-X* anti-missile missile.

$8,176,450—**American Machine & Foundry Co.,** New York, for production of unspecified ordnance items.

$7,700,000—**Radio Corp. of America,** Multi-system Test Equipment program. Burlington, Mass., to find a single test and repair system capable of servicing several future land combat missile systems.

$1,944,000—**General Motors Corp.,** Santa Monica Calif., for continuation of a re-entry study program.

$1,142,000—**General Electric Co.,** Syracuse, N.Y. for production of acquisition radars for use with the *Nike-Hercules*.

$800,000—**Radio Corp. of America,** Applied Research Dept., Camden, N.J., for a classified program.

$500,000—**Cubic Corp.,** San Diego, Calif., for four new *SECOR* satellites and electronic equipment.

$273,000—**Radio Corp. of America,** Missile & Surface Radar Div., Moorestown, N.J., for a classified program.

$215,034—**Architectural Design, Inc.,** Bellflower Calif., for *Bomarc* target systems facility.

$202,600—**B. B. McCormick and Sons,** Inc., Jacksonville Beach, Fla., for a corrosion protection project for the Air Force *Titan III* railroad system at Cape Kennedy.

$157,481—**Belock Instrument Corp.,** College Point N.Y., a contract modification for incremental funding for *Hawk* ATBM/HIP program, AN/TPQ-21 trainer.

$102,658—**Hercules Powder Co.,** Wilmington, Del. for one *Sprint* first stage motor case and one *Sprint* first stage nozzle.

NAVY

$18,000,000—**Baifield Industries,** Shreveport, La. for production of the *Snakeye* air-to-ground weapon system.

$6,933,054—**ITT Gilfillan, Inc.,** Los Angeles, letter contract to manufacture shipborne radar equipment.

$4,552,600—**Melpar, Inc.,** Falls Church, Va., for production of classified electronics equipment

$3,143,572—**Lockheed Aircraft Corp.,** Sunnyvale Calif., two contracts for work on Navy *Polaris* missile equipment.

$2,400,000—**Radio Corp. of America,** Communications Systems Div., Camden, N.J., for AN/RR-69 solid-state auxiliary ultra-high-frequency receivers.

$2,272,149—**Interstate Electronics Corp.,** Anaheim Calif., for *Polaris* test instrumentation.

$1,199,958—**Stewart Warner Corp.,** Chicago, for aircraft radar components.

$1,465,450—**Huyck Corp.,** Huntington Station N.Y., to manufacture computer display sets.

$1,058,838—**Sperry Rand Corp.,** Long Island City N.Y., for continued work on components for a gunfire control system.

$600,000—**Northrop Corp.,** Anaheim, Calif., for repair of *Polaris* checkout equipment.

$242,619—**Hercules Powder Co.,** Rocket Center W.Va., for engineering services on MK 13 gas generator program.

$92,000—**EPSCO,** Westwood, Mass., for the design, development and fabrication of a converter-multiplexer unit to be delivered to the U.S. Naval Applied Science Laboratory.

$82,086—**Electronic Communications, Inc.,** St. Petersburg, Fla., for a second generation developmental model of an advanced UHF telemetry transmitter.

United Aircraft Corp., Norden Div., to provide a laboratory evaluation model of the optical portion of the Norden reflective headup display system (amount not disclosed).

NASA

$270,000—**Cook Electric Co.,** Morton Grove, Ill. for the production of biomedical recorders for use in the *Gemini* manned space flight program

$268,000—**Radio Corp. of America,** Communications Systems Div., Camden, N.J., for a wideband television recorder.

Whose spacecraft* carries the most experiments?

*Orbiting Geophysical Observatory (OGO) built for NASA by TRW

22-39

TRW SYSTEMS

Formerly TRW Space Technology Laboratories (STL)

205,000—**Radio Corp. of America,** Astro-Electronics Div., Princeton, N.J., for *Applications Technology Satellite* ground support equipment for meteorological experiments.

117,175—**Ball Brothers Research Corp.,** Boulder, Colo., to define and determine the engineering requirements for a solar telescope mount to be used on proposed Earth-orbiting *Apollo* applications manned missions.

84,479—**Electro-Optical Systems, Inc.,** Pasadena, Calif., for an ion thrustor system.

80,700—**GCA Corp.,** Bedford, Mass., for meteorological experiments for manned Earth orbiting missions.

40,000—**USAF Systems Command** Space Systems Div., Los Angeles, for WECO guidance system and associated launch services for the LGO-F mission.

33,500—**Bell Aerospace Corp.,** Buffalo, N.Y., for design, modification, fabrication, test and delivery of electronic assemblies.

27,620—**Hewlett Packard,** Crossley Sales Div., Cleveland, for data recording systems.

INDUSTRY

3,000,000—**Radiation, Inc.,** Melbourne, Fla., from **Sylvania Electric Products,** Melbourne, Fla., for a tracking antenna subsystem to be used with a long-range tracking and instrumentation radar that will aid anti-missile studies.

1,493,000—**Radio Corp. of America,** Missile & Surface Radar Div., Moorestown, N.J., from **Massachusetts Institute of Technology** for modification to TRADEX radar.

400,000—**Radio Corp. of Americas** Aerospace Systems Div. from **Norden Co.,** Norair Div., Burlington, Mass., for a classified program.

287,000—**Stromberg-Carlson Corp.** from **Burroughs Corp.,** San Diego, Calif., for fifteen S-C 3070 electronic printers.

250,000—**ITT Cannon Electric,** Los Angeles, from **Raytheon Co.,** Missile Systems Div., Lowell, Mass., to furnish connectors for the *Sidewinder* missile program.

31,375—**EPSCO, Inc.,** Westwood, Mass., from Autonetics Div. of **North American Aviation** for production of signal conditioning modules for *Apollo* Space Capsule.

I-G Inc., from **Sandia Corp.,** for design, development and tooling for a miniature relay requiring original concepts as to contact current and environmental capability.

MISCELLANEOUS

100,000—**ITT Gilfillan, Inc.,** Los Angeles, Calif., from **Australian Navy,** for ground control approach radar equipment and associated electronics.

unker-Ramo Corp., Defense Systems Div. from the **Australian Navy** for its first fire control computer (amount not disclosed).

REQUESTS FOR BIDS

ir Force Special Weapons Center
rocurement Directorate
ttn: SWMKB
irkland AFB, New Mexico 87117

Negotiations are being conducted with NTW lissile Engineering, Inc., Los Angeles, Calif., for ollow-on work previously performed under Conact AF29(601)-6602. For information only; RFP ot available.

ASA
anned Spacecraft Center
eneral Research Procurement Branch
101 Webster-Seabrook Road
ouston, Texas 77058

Negotiations will be conducted with Bell Aeroystems Co. for the fabrication and testing of luminum ring stiffened *Apollo* configurations RCS ropellant tank shell. For information only; RFP ot available.

NASA Headquarters
Contracting Officer
Washington, D.C.

Negotiations are underway with Technology, Inc., for continuation of research on application of a statistical maneuver model of flight loads data to design criteria. For information only; RFP not available.

NASA Headquarters
Contracting Officer
Washington, D.C.

Negotiations are being conducted with TRW Space Technology Laboratories regarding continuation of investigation of interaction of high speed particles with gaseous targets. For information only; no RFP available.

Ballistic Systems Division
Air Force Systems Command
Norton Air Force Base, Calif.
Attn: BSRKG-3

The Ballistic Systems Division proposes to purchase 15 analog signal conditioning and telemetry units from the American Bosch Arma Corp., Garden City, N.Y., for support of the advanced ballistic re-entry system program.

NASA
George C. Marshall Space Flight Center
Huntsville, Ala.

Proposes to issue RFQ 1-6-52-01061 on or about Oct. 11 with a period of 25 days to be allowed for submission of proposals. The procurement will require the contractor to design and manufacture a 6-inch I.D. fluid dynamics facility in accordance with general specs. and descriptions. Request for the RFQ package should be in writing directed to NASA purchasing office MSFC, Huntsville, Ala., Attn: PR-RM Jerry McMurry prior to RFQ issue date Oct. 11, 1965. A limited number of RFQ packages are available, and will be provided on a first-come-first-served basis.

Air Force Flight Test Center
Directorate of Procurement (FTMKR-5)
Edwards Air Force Base, Calif. 93523
Attn: R. Andrade

Negotiations are being conducted with MHD Research, Inc., P.O. Box 1815, Newport Beach, Calif. Program calls for an investigation of high-energy storage concepts. This procurement is the result of an unsolicited proposal.

Procurement and Production Directorate
ATAC
Michigan Missile Plant
Warren, Mich. 48090

The following research and engineering requirement will be negotiated under an RFP modify and test one breadboard underwater sonic vision system. Proposal will be solicited only from Westinghouse Electric Corp. For information only; RFP not available.

Manned Space Flight Branch
Contracts Division
National Aeronautics and Space Administration
Washngton, D.C. 20546

NASA is negotiating with TRW Space Technology Laboratories, Redondo Beach, Calif., for feasibility study of new *Orbiting Geophysical Observatory* orbits and a spin-stabilized mode. For information only; no RFP available.

Eastern Area
Contracting Branch Nike-X Projects Office
Bell Telephone Laboratories
Whippany, N.J.

Propose to negotiate with Western Electric Co., 222 Broadway, N.Y. For additional R&D services in connection with *Nike-X* program. For information only; RFP not available.

Who built the world's only arms control system* for space?

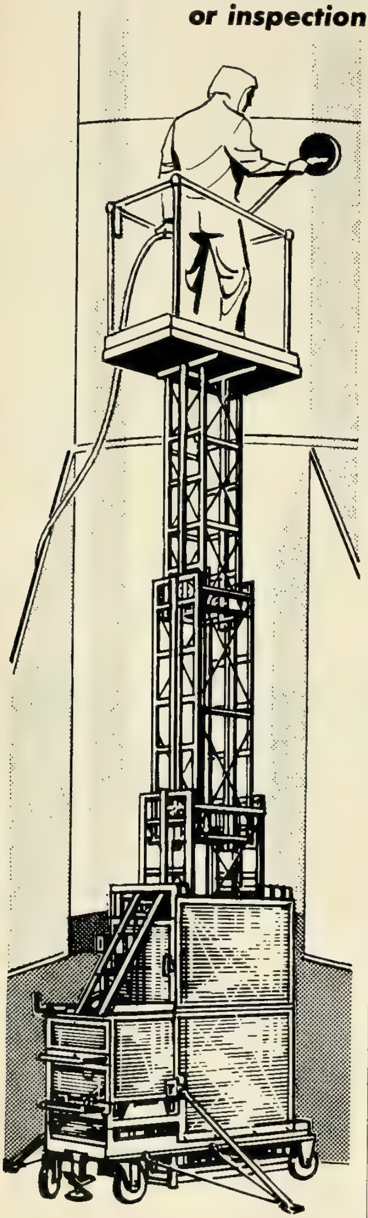
*6 Vela nuclear detection satellites to police the 1963 Nuclear Test Ban Treaty —*built for USAF by* ***TRW***

22-38

TRW SYSTEMS
Formerly TRW Space Technology Laboratories (STL)

ECONOMY LIFTERS

Reduce wasteful climbing on assembly for work or inspection



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names in the news

McCULLOUGH

SPEARS

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KENDALL

J. A. McCullough: Elected to the board of directors of Varian Associates. Also elected a director was **W. W. Eitel. Richard T. Orth** was elected as vice president of the Tube Group.

Gary N. Spears: Appointed manager of real time computations for Radio Corp. of America's Service Co. at the Air Force Eastern Test Range. He will be responsible for mathematical analysis, in-flight programming and real time computations for range safety, as well as other operations concerned with missile and satellite control and instrumentation checkout.

Dr. Harrell V. Noble: Named to head the Air Force Avionics Laboratory's Electronic Technology Div. at Wright-Patterson AFB, Ohio. He is the first civilian to direct one of the laboratory's four major divisions.

Dr. Perry E. Kendall: Named as manager, research and development, of the newly created Federal Systems Div. of AccuRay Process Control Systems.

Gen. Bernard A. Schriever: To deliver his first address to flight scientists and engineers on the Air Force *Manned Orbiting Laboratory* at the Oct. 12 banquet of the American Institute of Aeronautics and Astronautics Manned Space Flight Meeting in St. Louis.

Hamilton T. Holt: Named a vice president of HITCO's Materials and Research and Development Divisions. He was formerly manager of the two divisions.

Vice Admiral H. G. Rickover: Has been selected to receive the electrical manufacturing industry's Prometheus Award for 1965. He was cited for his leadership in furthering the development and use of nuclear power for war and peacetime purposes; also, for his contributions to science in the nation's schools.

James R. Flanagan: Joined Textron's Bell Aerosystems Co. as chief engineer of rocket and propulsion systems. He was formerly chief of liquid propulsion experimental programs at the NASA Office of Advanced Research and Technology.

Raymond A. Hundevadt: Appointed by the Lockheed Propulsion Co. as program manager for the company's submarine emergency ballast expulsion system program. He was formerly director of program analysis on the staff of the Chief of Naval Operations.

Lt. Col. Leslie G. Callahan, Jr.: Named the first director of the Avionics Laboratory, U.S. Army Electronics Command.

T. A. Campobasso: Appointed vice president of Collins Radio Co.'s Washington office. He has been with Collins for eight years.

Gerald A. Hoyt: Elected vice president of the General Electric Co. His responsibilities include the GE Defense Electronics Div., which produces *Polaris* missile guidance and fire control systems. Also, **Richard L. Shetler** has been made vice president of the company's Defense Programs Div. in Washington.

ENGINEERS

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—when and where—

OCTOBER

First International Water Desalinization Exposition and Symposium, sponsored by U.S. Department of State, Department of the Interior, and Atomic Industrial Forum, Inc., Sheraton-Park Hotel, Washington, D.C., Oct. 3-9.

20th Annual Instrument Society of America International Conference and Exhibit, Ambassador and Biltmore Hotels and Sports Arena, Los Angeles, Oct. 4-7.

Aeronautic and Space Engineering and Manufacturing Meeting, sponsored by Society of Automotive Engineers, Statler Hilton Hotel, Los Angeles, Oct. 4-8.

European Space Research Organization Meeting, Paris, Oct. 5-6.

Ultrasonics Conference and Exhibition, London, Oct. 5-6.

Eleventh National Aerospace Instrumentation Symposium, sponsored by Instrument Society of America, Ambassador Hotel, Los Angeles, Oct. 5-7.

Research and Development Cost Seminar, sponsored by NDEI, New York City, Oct. 5-7.

J. M. Burgers' 70th Anniversary Symposium on the Dynamics of Fluids and Plasmas, sponsored by Air Force Office of Scientific Research (AFOSR), University of Maryland, College Park, Oct. 6-8.

1965 Congress of the International Federation for Documentation, sponsored by AFOSR, Office of Naval Research, Army Research Office, National Science Foundation and Council on Library Resources, Washington, D.C., Oct. 7-16.

Pan American Congress of Electrical, Electronics and Mechanical Engineering, sponsored by Institute of Electrical and Electronics Engineers, American Society of Mechanical Engineering, Society of Automotive Engineers, Hotel Del Prado and Auditoria Nacional, Mexico City, Oct. 9-17.

Annual Meeting of the Users of Automatic Information Display Equipment, Holiday Inn, New York City, Oct. 11-14.

International Congress and Exhibition for Instrumentation and Automation, sponsored by the Nordwestdeutsche Ausstellungs-und Messe-Gesellschaft mbH (NOWEA), Dusseldorf, Germany, Oct. 13-19.

25th National Convention of the Society for Nondestructive Testing, Cobo Hall and Embassy Hotel, Detroit, Oct. 18-22.

Electronic Packaging Conference, sponsored by the Society of Automotive Engineers, Inc., International Hotel, Los Angeles, Oct. 20-21.

1965 International Electron Devices Meeting, sponsored by the Institute of Electrical and Electronics Engineers, Sheraton-Park Hotel, Washington, D.C., Oct. 20-22.

Third Annual Conference on Energy Conversion and Storage, sponsored by Oklahoma State University School of Electrical Engineering, Stillwater, Okla., Oct. 28-29.

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The Ugly American

Thessaloniki, Greece

THE DATE of September 17, 1965, is one that will be long remembered in this ancient Macedonian capital of Alexander the Great. On that day astronauts Gordon Cooper and Charles Conrad brought the new world of the Space Age in touch with one of the oldest civilizations of the Classical Age.

The visit to Greece at the beginning of the astronauts' swing through the Middle East and Africa was eminently successful. The acclaim in Athens was moderate—the edge of the visit was dulled by the fact that Soviet cosmonauts Belyayev and Leonov already had been in the city for four days. But in Thessaloniki, an hour's flying time north of Athens, the welcome was overwhelming.

When the mayor of Thessaloniki, in presenting the Americans with the golden medal of the city, told them "You gave wings to the imagination of man," it was clear that the message of *GT-5* had indeed reached the four corners of the Earth.

President Johnson's decision to send the astronauts on an international goodwill mission will reap multiple benefits. It is all the more unfortunate, therefore, that the behavior of a short-tempered, unimaginative public relations official from the National Aeronautics and Space Administration cast an unnecessary cloud over the very beginning of the visit.

The facts are these. An American television network, taking at face value President Johnson's expressions of interest in international space cooperation, set out to arrange in Athens a filmed interview between American astronauts Cooper and Conrad and Soviet cosmonauts Belyayev and Leonov. The four were present at the Athens meeting of the International Astronautical Federation.

The representative of the network, acting on what he and his company believed were prior commitments from NASA, approached the Soviets and obtained agreement for the confrontation. What happened next perhaps is best explained in the words of Soviet Academician Leonid Sedov, head of the Russian delegation, to a press conference the following day:

"Recently I was approached by authorities of the International Astronautical Federation, American scientists and representatives of the American Broadcasting Company with a suggestion to shoot a film on the American astronauts and Soviet cosmonauts. We willingly gave consent because we thought it a very nice way of furthering international cooperation. We were on time for this meeting. We were there. All the camera operators were ready. The cosmonauts were ready and the representatives of the American scientists were there and, among others, Congressman George Miller (chairman of the House Space Committee). We waited for half an hour but the astronauts failed to appear."

The astronauts were not there because the NASA public relations official concerned made an on-the-spot decision against their appearance. They were, it should be noted, free of any other engagements at the time.

The NASA press officer explained his decision to a press conference the following day in these words:

"When we arrived here yesterday, we learned for the first time an American network was seeking to arrange an exclusive interview between the American astronauts and Russian cosmonauts. We do not grant exclusive interviews but we conduct our business openly and equally before all news media."

The editor of this magazine can say, of his own knowledge, that NASA was aware of the effort being made to arrange the interview because, prior to arrival of the astronauts, a NASA advance man on the scene was in touch with Washington concerning arrangements for the interview. The network says it had contacted NASA some days previously, and, in view of the expense involved in flying in camera crews, this seems likely.

As to the second part of the statement, we can see no reason to penalize an American network for its enterprise in arranging a session so obviously in line with Presidential policy.

BELYING THE PIOUS TONE of the statement, it should be pointed out that when the confrontation between the astronauts and cosmonauts did take place two days later, in a private meeting from which all news media were excluded, the NASA public relations official immediately thereafter led a representative of *LIFE* magazine into a hotel room for a discussion with the astronauts about the meeting. He had refused to let other news representatives talk to them on the subject. Just how that can be described in terms of "we conduct our business openly and equally before all news media" is beyond us.

This was not the only example of poor public relations. A press conference held by the astronauts in the Athens Hilton, under the direction of the same NASA press officer, conflicted directly with presentation of papers by the two Soviet cosmonauts at an IAF plenary session in the hotel, overlapping by some 45 minutes. Out of courtesy, it should have been cut short. The following day, the Soviets graciously cut off just such a press conference to avoid conflict with the appearance of the American astronauts at an identical plenary session.

On the flight to Thessaloniki in an Air Force executive aircraft, the NASA press official actually laid hands on the ABC man present and slammed him bodily out of a compartment, to the embarrassment of all present, including astronauts Cooper and Conrad and American and Greek newsmen.

The entire affair was an intemperate display of poor NASA press relations, marring a meeting otherwise characterized by unusually cordial international cooperation.

William J. Coughlin

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OCTOBER 11, 1965

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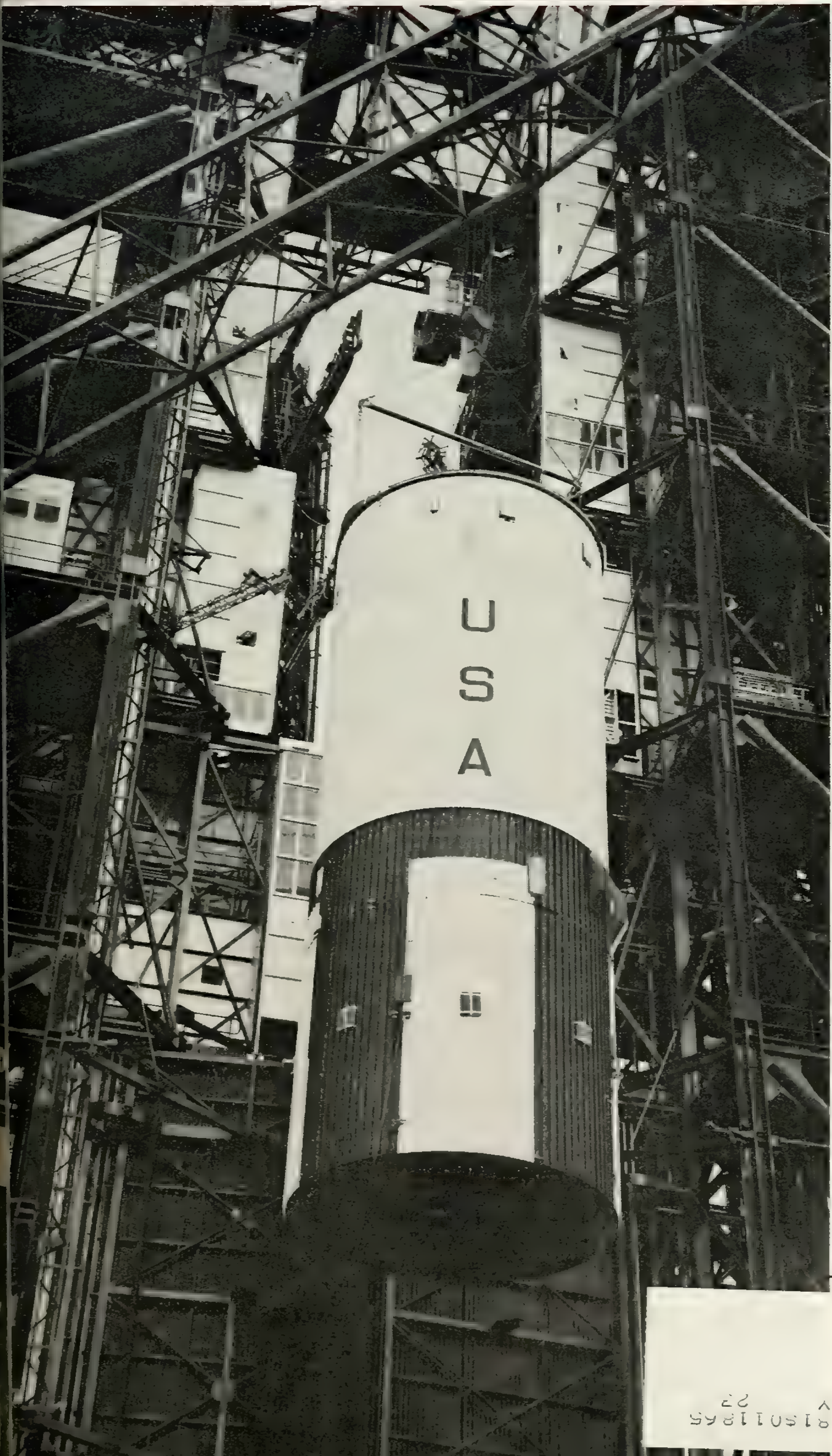

Hypersonic Work Adding to X-15's Life Expectancy

DDR&E Revamp Nears Completion

Air Force Fights 156-in. Demise

Big High-Energy Physics Push Seen

Saturn S-IVB Stage Being Erected at Cape

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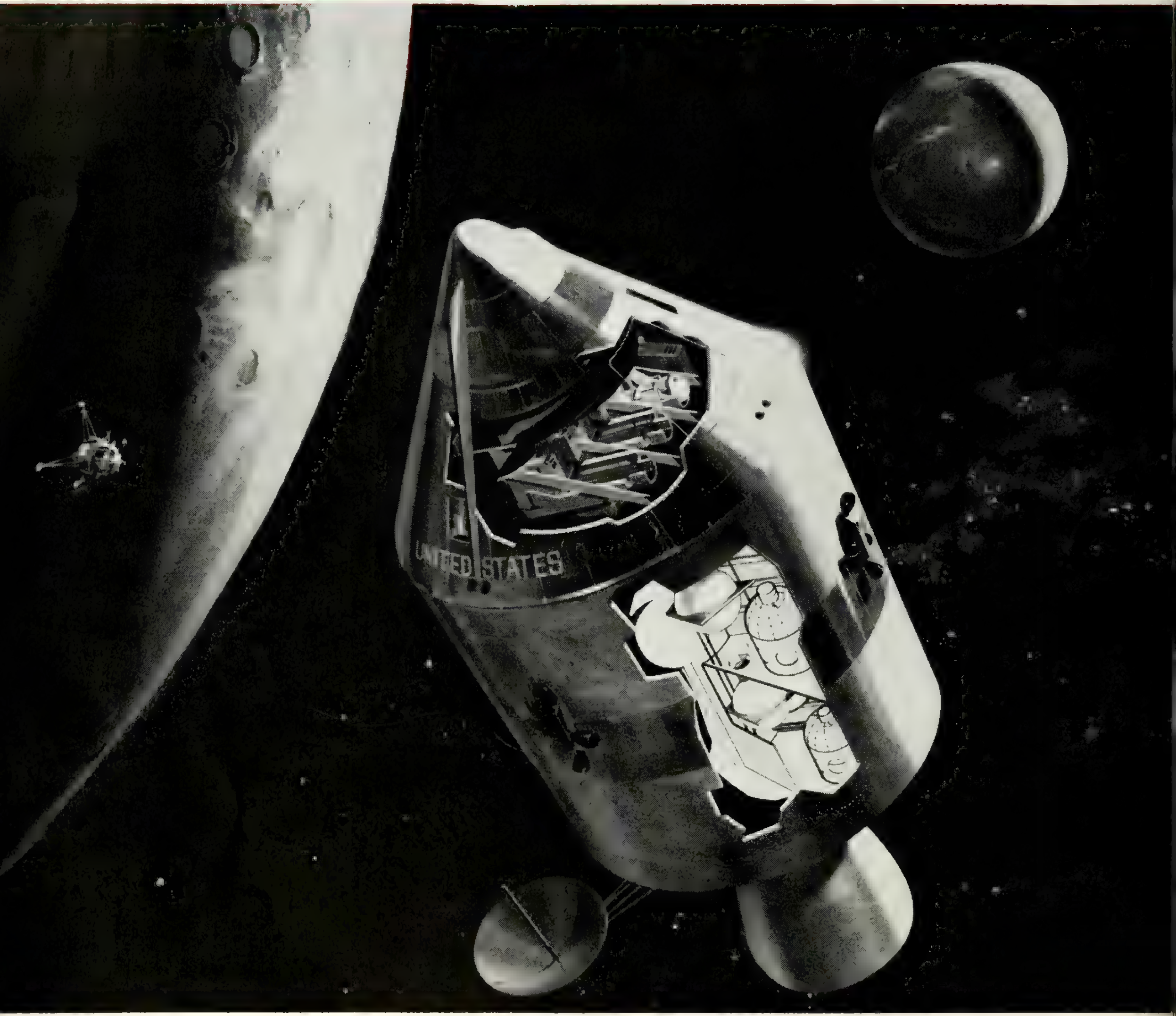

Shirtsleeves environment in space: Beech's job for NASA's Project Apollo

Beech selected to develop and build Cryogenic Storage Subsystem for life support and electrical power

When American Astronauts embark on their upcoming journey to the moon, they can doff their spacesuits and travel in a comfortable "shirtsleeves" atmosphere. Responsibility for the design, development, manufacture and testing of the storage systems to provide that atmosphere has been given to Beech by North American. The same systems will also supply the gases to generate power for the command module.

The selection of Beech for this vital task is based on solid accomplishment and proven reliability. A pioneer in Cryogenics, Beech has been active in the design, development, manufacture and testing o systems and sub-systems for many of our rocket and missile programs.

A comprehensive physical facility has been created and staffed by experienced experts. Many of these facilities will be used to fulfill Beech's systems management responsibilities for Apollo.

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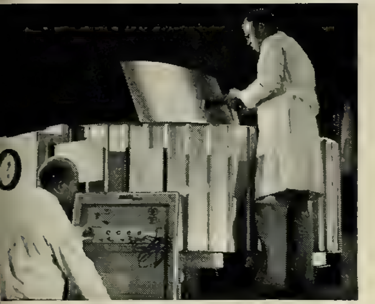
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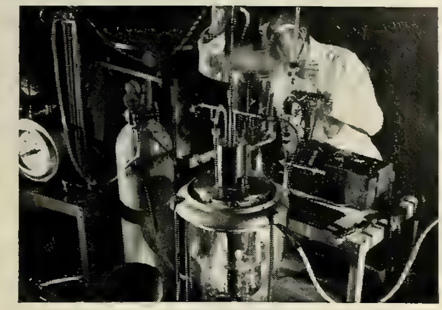
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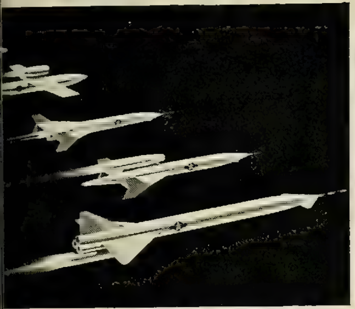
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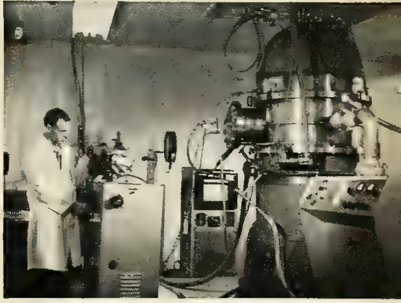
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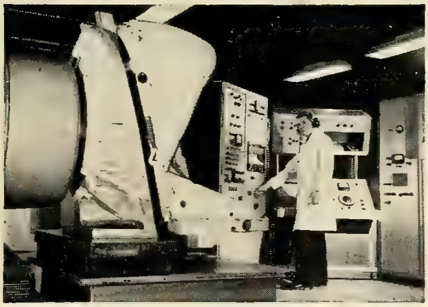
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That's how the first firing of Lance was described as this new breed of Army missile scored a smashing bullseye.

Currently undergoing rigid development tests by the Army, the Lance missile already has been successfully fired from the lightweight launcher and the self-propelled launcher (XM687). The complete system — including Lance's companion vehicle, the XM688, a modified, full-tracked armored transporter-launcher capable of carrying two missiles — has been torture-tested under all types of weather and terrain, including air-drop.

The first Army missile to utilize pre-packaged storable liquid propellants, Lance is uniquely qualified for its mission. It is light, rugged, reliable, easy to operate, highly mobile and versatile — yet low in cost.

Lance can be moved swiftly into battle by helicopter, air-dropped by parachute, or carried by ground vehicles over rough terrain under all weather conditions.

A key factor in Lance's accuracy is its use of a newly developed inertial guidance and control concept. Utilizing this concept, Lance combines outstanding battlefield accuracy and range of a guided missile with the low cost and reliability of a free rocket.

Designed to consistently deliver effective nuclear or non-nuclear warheads in support of fast-moving and flexibly employed forces, Lance represents a new breed of Army artillery. It has been designed to replace Honest John missiles. Prime contractor is the LTV Michigan Division.

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THE COVER

Saturn S-IVB stage being erected at Complex 34 at NASA's Kennedy Space Center. The Douglas second stage was mounted atop the first stage Oct. 1. First launch of the complete Saturn IB is expected late this year or in early 1966. See p. 17 for a detailed Saturn-Apollo launch schedule.

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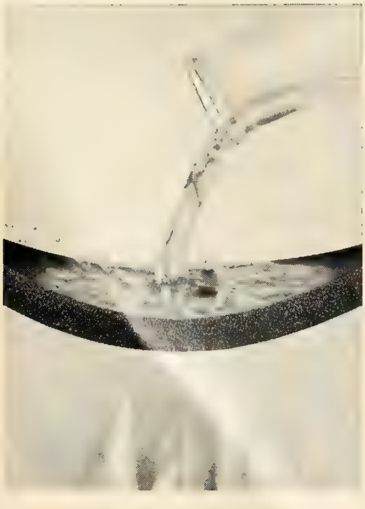

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letters

Air Force Economies

To the Editor:

In one of your recent issues I noticed an article on the financial antics of the Aerospace Corporation, which were supported by the Air Force with extravagant expenses.

It is my happy duty to assure you that the Air Force more than makes up for this extravagance by its tight-fisted policy as regards engineers and their technological status quo.

Let me illustrate: An engineer asked for permission to attend a five-day seminar to review advanced techniques in the area in which he works. He offered to pay for the fee himself if the Air Force would reimburse him for the transportation. Refused in harshest terms, he offered to pay for the whole thing himself, but was refused again, because he had not earned sufficient annual leave, and had no vacation coming at the time.

Can anyone find fault with such economy-minded management policies???

Henry Albert
No. Hollywood, Calif.

AFCRL Magnetics

To the Editor:

The table entitled "Comparison of Various Magnetic Simulation Facilities" contained in the article "Attitude Control Testing Advanced by Sophisticated Magnetic Facility" (M/R, Sept. 13, p. 22) is incomplete. The Air Force Cambridge Research Laboratories maintain a low field coil system as part of their Magnetic Test Facility located at Weston, Mass.

The Braunbek-configuration coils have a maximum diameter of 90 inches and a field intensity range capability of from 5 to 120 K gamma. A field homogeneity of 0.001% is maintained over a 2-ft.-dia. sphere, resolution accuracy is 0.6 gamma, and diurnal compensation is manual.

Robert O. Hutchinson
Space Physics Laboratory
Air Force Cambridge Research Laboratories
L. G. Hanscom Field, Bedford, Mass.

Martlet-type A-ICBM's?

To the Editor:

Your Sept. 13 issue (pp. 16 & 17) portrays very interesting pictures of Soviet missiles. The last photo (7) is said to depict the launch of an A-ICBM that is "*Sprint*-like," the *Sprint* being a gas pressure-launched A-ICBM.

However, the photo shows a white muzzle-flash at the end of the launcher which contrasts with the black or gray smoke elsewhere. If this rocket is in fact explosively launched from a large gun bore, it then is more like the *Martlet* rocket than the *Sprint*.

The *Martlet* rockets are developed by the unclassified HARP program as a joint Canadian-American project controlled by engineers at McGill University (M/R, July 1, 1963; Jan. 27, 1964). Owing to the fact that the missile briefly sustains 10,000-g acceleration in the gun bore in achieving a muzzle velocity of nearly 5,000 ft./sec., shock-sensitive inertial components cannot be used in its guidance. Nonetheless, the less precise guidance scheme chosen for the three-stage *Martlet IV* is deemed capable of achieving usefully accurate orbits for its scientific-type payloads.

David E. Matzke
Kensington, Md.

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parking space

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(Additional opportunities in space as well as aircraft programs, on following page)

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(Continued from previous page)

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Senior Thermodynamicists—Advanced degree with minimum of 5 years experience performing heat transfer analysis. Specific opportunities in aerodynamic and re-entry heating, structural temperature determination and heat transfer phenomena in propulsion systems.

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R&D Electronic Flight Test Engineers—B.S. in E.E. or Physics plus test experience in Electronic Airborne Systems including Radar, computer, navigation & guidance, stabilization & control & communications equipments for application to space programs.

Spacecraft Mission Planning & Analysis Engineers—Will be responsible for mission test planning of LEM flight development programs involving preparation of test plans; determination of in-flight & ground test constraints & requirements; preparation of fluid/mechanical systems flight test operations plans; time-line analyses; liaison with design & system analysis engineers; liaison with NASA agencies. BS or advanced degree required. Exp in advanced systems or preliminary design in aircraft flight test, spacecraft test operations or systems testing of fluid/mechanical spacecraft systems is particularly valuable.

Spacecraft Mission Control Engineers—Opportunities exist in a small group responsible for flight control operations & fluid/mechanical systems test monitoring. Duties involve planning, preparation for & monitoring of vehicle fluid/mechanical systems flight tests during space development missions. BS degree & thorough knowledge of one or more of the following required: propulsion system test; crew systems test; environmental control systems test. Work will be performed in Mission Control Center at Houston, Texas.

Spacecraft Systems Simulations Engineers—BS degree & fluid/mechanical systems simulation experience required. Responsibilities will include: Support of LEM mission control operations; determination of system malfunction implications; assist in preparing exercises & training simulations; setting up operational procedures; manning simulations console. Work will be performed in Mission Control Center at Houston, Texas.

Site Activation Engineers—B.S. degree or equivalent with pertinent experience in field site installations & validations of checkout and ground support equipment. Responsibility includes planning, establishment of facility requirements, validation & activation of fluid & mechanical equipment.

Spacecraft Systems Checkout & Development Test Engineers—BS degree required with pertinent experience in checkout tests of spacecraft fluid/mechanical systems particularly in the areas of: Environmental control & life support systems, liquid rocket propulsion systems & structural/mechanical systems. Will work in an expanding group covering all phases from test planning & test procedure writing to final systems checkout or development tests. Long term field assignments will be made to either Cape Kennedy for LEM prelaunch checkout or to MSC, Houston for LEM system development tests.

Rocket Engine Test Engineers—BS degree required to conduct tests on hypergolic liquid fuel rocket engines under atmospheric & simulated altitude conditions at White Sands, New Mexico. Duties include: initiation of test procedures; determination of functional requirements; monitoring installations, validation & operation procedures; conducting & monitoring systems tests for full scale engine test firings.

Spacecraft Life Sciences Engineers—BS or MS degree in Life Sciences or Aerospace Medicine. Work will include test planning, determination of safety requirements & procedures; conducting manned spacecraft systems tests under 100% oxygen & hard vacuum conditions with particular emphasis on interaction between astronauts & his displays, controls, & operational procedures.

Advanced Systems Test Operations Engineers—BS or MS degree with experience in advanced systems & preliminary design. Will initiate & develop test operational concepts for current & future spacecraft development programs including: conducting studies; organizing, writing & editing proposals; preparation of presentations; & determining customer requirements.

Logic & Switching Engineers—BSEE with 3 to 5 years experience in digital logic, timing & control, arithmetic elements and time sharing systems. Must be capable of developing a detailed logic design from system specification. Should be able to perform detailed system analysis to minimize hardware, eliminate hazards and timing problems and specify testing requirements.

NOTE: Positions also available in the above areas to February or June '65 Engineering Graduates

Use the attached inquiry form to arrange a mutually convenient interview.

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CITY & STATE________ TELEPHONE________

NEAREST MAJOR CITY (IF APPLICABLE)________

COLLEGE GRADUATE: YES___NO___

Degree	Subject	Year

Major Specialty______Yrs.______Other Specialty______Yrs.______

Applying for position(in)(of)________

Background and experience (Brief resume of experience, recent history of employment. If available, attach prepared resume.)

Circle No. 3 on Subscriber Service Card

The Countdown

WASHINGTON

New Bullpup Buy Would Be Competitive

Any new production of the *Bullpup* missile for Viet-Nam, either with reprogrammed FY '66 funds or new FY '67 money, will be competitive. That's the word from project sources. *Bullpup* still is in production with FY '65 funds under a sole-source contract with Maxson Electronics Corp. Introduction of the *Bullpup C* with a 750-lb. warhead has greatly improved effectiveness over earlier versions which carried a 250-lb. warhead, too small for many targets.

SRAM Award Expected By Nov. 15

Four-month contract definition awards for the *Short Range Attack Missile (SRAM)* are expected by Nov. 15. Air Force sources now say at least two of the four firms still in the running will get contracts for phase IB of the development effort. A single contractor then will be selected next year for the engineering development and production phase. Companies competing are Martin, Boeing, McDonnell and North American.

Hot Pace Continues on Gemini Program

NASA's fast-moving *Gemini* project now finds *Gemini 7* ready for Cape Kennedy, with shipment of the 14-day mission spacecraft from McDonnell Aircraft scheduled over the past weekend. The *Gemini 7* launch vehicle is to leave Martin Co.'s Baltimore plant for the Cape *Titan II* launch complex about the same time *Gemini 6* goes into orbit late this month. There's still a chance of getting *Gemini 7* off before year's end, which would give NASA an impressive record of five manned and one unmanned flights in the program during 1965.

Navy To Transfer Nuclear Force

Navy's planned transfer of its four-ship nuclear-powered task force from the Atlantic to the Pacific will begin later this month with departure of the USS Enterprise and the guided missile frigate USS Bainbridge. Two other nuclear-powered guided missile ships, the cruiser Long Beach and frigate Truxtun, will head West next year.

Poseidon Propulsion Award Imminent

Contracts for the two-stage solid-fuel propulsion system for the Navy's *Poseidon* fleet ballistic missile will be awarded within a month. That's what Rear Adm. Levering Smith, director of the Navy's Special Project Office, tells COUNTDOWN. Three firms are competing. Aerojet-General has bid on both stages; Hercules Powder has bid on the second stage; and a Hercules/Thiokol team has bid on the first stage.

Astronauts May Wear Hard Hats

Standard Air Force "hard hat" flight helmets and oxygen masks have been ordered by NASA from Sierra Engineering Co. for evaluation as possible gear for *Gemini 7* astronauts Frank Borman and James Lovell. If approved, standard flight coveralls would be worn with them. A spokesman for Manned Spacecraft Center says decision on flight gear for the 14-day mission still is pending while a lightweight, one-piece garment which includes helmet and visor is evaluated. This was designed by David Clark Co., Worcester, Mass.

Marshall Studies Venus Flybys

A major study effort during the coming year at Marshall Space Flight Center will concentrate on manned Venus flyby missions. According to William Huber of MSFC's Advanced Systems Office, such a flight could be made in the 1975-77 period, after the initial lunar landing and prior to a first landing on Mars.

Karth Report on Surveyor Completed

Rep. Joseph Karth (D.-Minn.) has completed his study of the *Surveyor* program for House Space Committee Chairman George Miller (D.-Calif.). It's not yet known whether the committee will make the report public.

INDUSTRY

Go West, Young Man

Stanley Hiller, Jr. is pulling out of Fairchild Hiller Corp. in favor of his private interests in California in banking, land and building investments. He was executive vice president, member of the executive committee and a corporate director. He will continue as a consultant.

Corning Claims Fluidics Mark

Delivery of more fluidic amplifiers than any other company in the industry is claimed by Corning Glass Works, which has recognized the achievement with formation of a Fluidic Products Dept. The firm recently turned out for Redstone Arsenal a fluidic missile guidance package which will operate between a gyro and a supersonic bistable amplifier in the missile exhaust stream.

Lockheed Motor Scores 100%

Lockheed Propulsion Co. reports a new high-mass-fraction solid rocket motor has scored a 100% success in research and development flight-testing. The XSR-1-LP-1, with a glass fiber case and partially submerged nozzle, is a high-energy upper-stage rocket containing over 500 lbs. of double-base nitroplastisol propellant. Thrust level of the motor, designed to serve as a versatile, easily storable third or fourth stage for orbiting scientific payloads, is in the 10,000-lb. class. Produced in less than six months, the motor is 60 in. long and 18 in. in diameter.

NASA Seeks ATS Follow-on for 1969-70

Industry has been asked by NASA to bid on a six-month study of a follow-on *Applications Technology Satellite* program known as *ATS-4*. This calls for continuation in the 1969-70 period of investigations undertaken by the first three *ATS* satellites. Bids are due Oct. 15 on the proposal, which calls for definition of feasibility, a development plan and cost estimates.

INTERNATIONAL

Soviets To Open Tracking School

The Soviet Union is opening an international school at Tashkent to train specialists in satellite tracking. Fifteen scientists from Rumania, Bulgaria, Hungary, East Germany, Mongolia, Czechoslovakia and Poland will join 20 Russian astronomers for training as specialists in photographic observation of satellites against the stellar background. The school is being set up within the framework of the United Nations International Commission for Space Research. A report on it is to be given at the next COSPAR meeting.

The Missile/Space Week

Soviets Heighten Lunar Race

The U.S. may be at least 2 and probably about 6 months behind the Soviet Union in unmanned exploration of the Moon as a result of the Russian *Luna 7* spaceflight.

The Russians reported late on Oct. 6 that the spacecraft was due to reach the Moon at 6 p.m. EDT, Oct. 7. While the Russians have not said so officially, most U.S. space experts expected that the spacecraft would attempt to soft-land on the Moon and then send data, including television pictures, back to Earth.

The first such U.S. attempt is not scheduled until late December, but U.S. officials expect it to slip by at least 1 month. U.S. officials are also not very optimistic on the chances of the first few *Surveyor* spacecraft actually going to the Moon and completing a soft-landing successfully.

The first four spacecraft in the program are considered engineering and test spacecraft. Operational spacecraft will begin with the fifth mission.

The Russians earlier this year apparently made two other attempts to soft-land on the Moon but both were unsuccessful.

The 3,318-lb. *Luna 7* was launched on Oct. 4 by what the Russians call a multi-stage launch vehicle.

S-II Test Model Readied

The first complete test model of the *Saturn V* S-II second stage is scheduled to arrive at NASA's Mississippi Test Facility late this week.

The S-II-T all-systems test vehicle was shipped from Seal Beach, Calif., Oct. 1 by North American Aviation's Space and Information Systems Div. S-II firings are slated to begin early next year on a test stand now nearing completion at MTF.

Primary mission of the test stage is to provide development testing of integrated S-II flight systems and hardware under static firing conditions. Other missions include the verification of ground support equipment capabilities and aiding in the transition from testing heavy models to flight-weight structures.

One structural test model of the S-II stage of the *Saturn V* was destroyed Sept. 29 during testing at North American Aviation's Seal Beach, Calif., facility.

The stage was in a compression test that had progressed well beyond the maximum load that could be expected in actual flight. The test, in which the stage was loaded with 400,000 gallons of water, was approaching the ultimate load when the structure failed.

Air Force OV-1 Mated to Launch Vehicle

OFFICE OF AEROSPACE Research OV-1 satellite is shown being mated to Atlas-D booster by General Dynamics/Convair technicians prior to Oct. 5 launch (see Shots of the Week, p. 11). A dummy satellite on the opposite side of the pod counterbalances the OV-1. Shown on its dolly (center) is a scientific passenger pod (SPP), which carried five experiments on a suborbital flight.

Valve Slips Titan III-C Shot

The second launch of the Air Force's *Titan III-C* launch vehicle, scheduled for Oct. 8, has been postponed until Oct. 14.

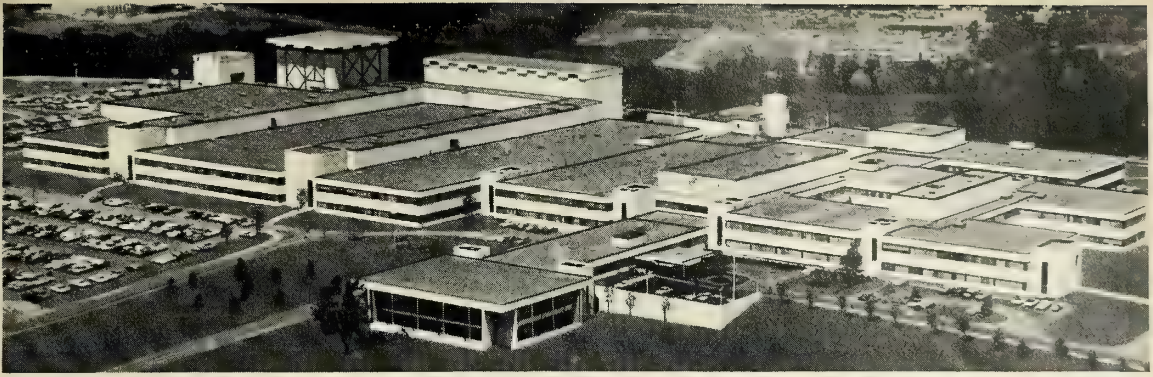
Project officials decided on postponement Oct. 6 after receiving word from the Martin Co. plant in Denver that a contamination problem was discovered in the Transtage helium pressurization system valve, being assembled in the Martin plant. During a routine test in the Denver plant, one of the valves failed to open. Investigation revealed contamination in the fluid. The contaminant scored the shaft of the valve.

Program officials cycled a similar valve installed in the *III-C* Transtage on Pad 40 at the Integrate-Transfer-Launch (ITL) facility. The valve worked perfectly, but officials decided to delay the launch and replace the valve system with a new one that will have been checked out at the Denver plant.

GTA-6 TV Coverage Pondered

Shipboard tests will take place early this week to determine the feasibility of live television coverage of the recovery of the *Gemini 6* astronauts.

Western Union International and International Telephone and Telegraph Corp. will use their telecommunications equipment aboard the USS Wasp to test television transmission to the U.S. through the *Early Bird* communications satellite. Columbia Broadcasting System, representing a pool of broadcasters, will evaluate the service provided by each common car-



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rier. The test also will allow NASA and the Defense Dept. to determine if the equipment on the ship will interfere with recovery operations.

Shots of the Week

The Air Force used an *Atlas-D* booster to launch the *OV-1* aerospace research satellite from Vandenberg AFB, Calif., Oct. 5. The satellite, which was developed by the Air Force's Office of Aerospace Research, carried with it a test to determine radiation shielding requirements of humans and an experiment designed to map and monitor particle radiation in space. The *OV-1* powered itself into a 1,300-mi. orbit from a pod situated atop the *Atlas* (see photo, p. 10).

- A *Minuteman II* scored that ICBM's 11th consecutive success in a launch Oct. 1 from Cape Kennedy.
- The USSR launched an unmanned *Luna-7* spacecraft toward the Moon Oct. 4 (see p. 10).
- A NASA-launched, Pennsylvania State University-developed scientific probe of the upper atmosphere failed Oct. 6, apparently after a separation mechanism on the "mother-daughter" payload failed to operate properly. A four-stage *Javelin* rocket carried the probe to an altitude of 577 mi., but no data were received from the instruments.

GT-5 Nets Gegenschein Photos

Astronauts Gordon Cooper and Charles Conrad, Jr., successfully photographed Gegenschein, the mysterious sky glow that has long puzzled scientists and evaded attempts at photographing it, during the flight of *Gemini 5.*

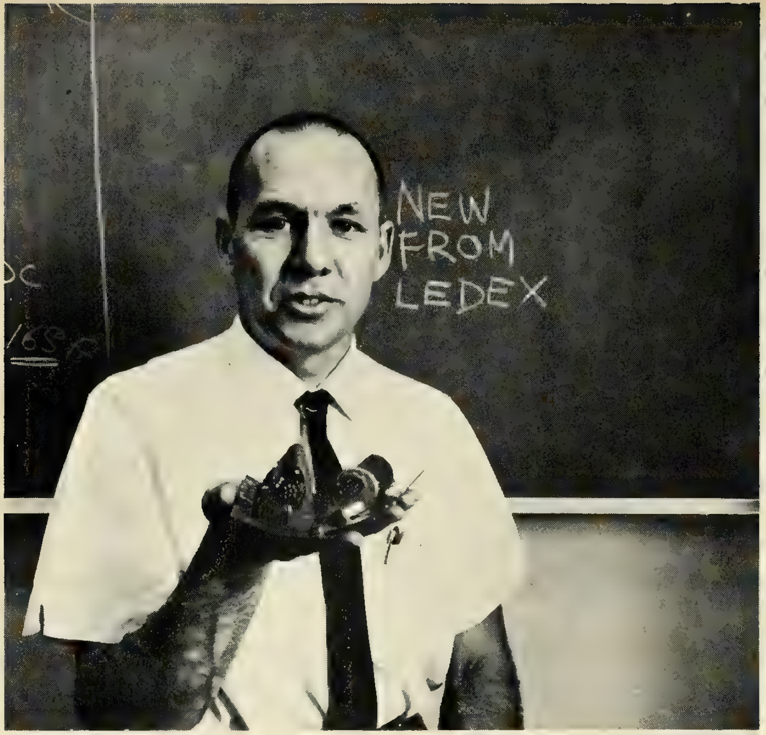
Two University of Minnesota astrophysicists, E. P. Nye and W. F. Huch, disclosed this fact in *Science,* the journal of the American Association for the Advancement of Science.

The photographs indicate that the Gegenschein represents a backscatter of light from dust particles circling the Sun in wider orbits than that which the Earth follows. Origin of the particles remains unknown.

Comsat Seeks Apollo Role

Comsat has applied for FCC approval to let a contract for construction of four synchronous satellites to provide communications services for the *Apollo* program, as well as for other commercial uses (M/R, Oct. 4, p. 9).

The corporation is also expected to file early this week for authorization to build up to eight portable



**Here are two new intervalometers,
one solid state, one electromechanical**

Both of these recycling timers are completely interchangeable in form, fit and function. Both are capable of optional single or ripple firing of seven rockets at 15 millisecond intervals.

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ground stations for use in the new system.

The National Communications System, a coordinating agency for Government communications needs, is still evaluating the proposal it requested from Comsat for the service. A decision is expected in the near future since the original NCS request called for delivery of the first satellites and portable Earth stations by next fall.

Under Comsat's filing, two Hughes Aircraft Co. satellites would be placed in synchronous orbit by next summer to meet NASA's *Apollo* requirements, in addition to providing some 100 voice circuits for commercial use. One satellite would be placed over the Pacific Ocean between Hawaii and Midway Island and the other over the Atlantic Ocean near the west coast of Africa. Two other satellites would be built as back-ups.

In effect, each satellite would be two *Early Birds*, with weight in orbit of some 170 lbs. and multiple access capability. The only new features, from a design standpoint, would be the larger structure, incorporation of a quasi-linear transponder and parallel operation of traveling-wave-tube amplifiers.

Estimated cost of the system is more than $80 million for a 10-year period.

Communications Satellite Corp. has issued RFP's to 20 firms for site preparation work for an Earth station at Brewster Flat, Wash.

Bids are due Oct. 15. Work is expected to begin early next year on the station.

The request includes clearing and grading, laying of foundations, subsurfacing roads and other preparatory work.

Sterilization Session Open

The space agency's first National Conference on Spacecraft Sterilization Technology will be open to the scientific community and the aerospace industry.

The meeting, hosted by Jet Propulsion Laboratory, will be held Nov. 16-18 in Pasadena, Calif. Sessions will review progress made in sterilization techniques and discuss means of solving future problems (M/R, Sept. 20, p. 10).

Boeing Strike Settled

An agreement between The Boeing Co. and the Aeromechanics Union ended a 19-day strike affecting 34,000 union members at all Boeing facilities, including Cape Kennedy.

Main concession made by Boeing allows for replacement of the performance analysis system, a change that had been advocated by union officials.

Metal-Forming Report Available

NASA has available a technology utilization report on metal-forming techniques currently in use in the aerospace industry.

The 52-page report outlines 24 metal-forming techniques, including some in the experimental stage. Copies may be obtained for 40¢ each from the Supt. of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Missile Ships Readied

The USS Carronade and the USS White River, two Navy rocket-firing ships, have been recommissioned with indications that they will be sent to Viet Nam.

Rear Adm. Robert C. Early, speaking at ceremonies at the Long Beach, Calif., naval shipyard, said American troops in South Viet Nam "need their guns and rockets and will get them."

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Research Program Extending X-15 Life

New delta-wing configuration of # 3 aircraft may be flight-tested in FY 1967 and flown beyond 1968; Lewis may get new test facility

by Hal Taylor

SPACE AGENCY PLANS for hypersonic research now call for flight tests of a delta-wing configuration *X-15* airplane and new test facilities, perhaps in Fiscal Year 1967.

Albert J. Evans, deputy director of aeronautics in the Office of Advanced Research and Technology, told MISSILES AND ROCKETS that while no final approval has been obtained, the space agency is making in-house studies on whether a delta-wing *X-15* would be technically feasible.

The new configuration, he said, would permit NASA to get information on the use of the winged design at hypersonic speeds. He said that a decision probably would be made before the end of the year. If approval is given, NASA will contract with a private industrial firm for a design study of the modifications that must be made to the basic *X-15* aircraft to achieve the new flight configuration.

It is believed that the new plane—if approved as expected—will be flown after 1968. Plans call for modifying *X-15* #3 for the new program.

Evans said the plane could be used to validate data on hypersonic research obtained in ground test facilities. It would also be helpful in obtaining information as to what additional ground facilities are needed.

The lack of ground facilities has long been one of the major roadblocks in hypersonic research programs, which, in addition to hypersonic commercial aircraft plans, could also lead to the so-called aerospace plane, which could be launched from Earth, go into orbit and then return to Earth.

- **New funds anticipated**—Another NASA official indicated that the space agency would request funds in FY '67 for some of the needed new ground facilities. He said the money would be used for a propulsion test facility that could check out air-breathing ramjet power systems. The likely location for such a facility, reportedly, would be the Lewis Research Center, Cleveland, NASA's major field installation for propulsion research.

Other NASA officials also outlined future *X-15* experiments at the Fourth *X-15* Technical Conference held recently at the Flight Research Center, Edwards, Calif.

The list includes ultraviolet stellar photography and exhaust plume characteristics, horizon definition, atmospheric density measurements, meteorite collection, vapor cycle cooling, horizon scanning, a supersonic deceleration device, high-altitude sky brightness, an infrared scanning radiometer and measurement of the infrared and solar spectrum.

Flights with the experiments will carry at least one of the three *X-15* rocket planes into 1968.

The horizon scanner project involves research coupled with space launches. It will eventually be used in the midcourse maneuver of the *Apollo* spacecraft. The stellar photography experiment is a prototype of equipment in the *Orbiting Astronomical Observatory* program.

- **Computer refinement**—Paul S. Bikle, director of the Flight Research Center, said that *X-15* #3 will also be modified next month for the installation of a new, operational "energy management system." This major component is a lightweight computer.

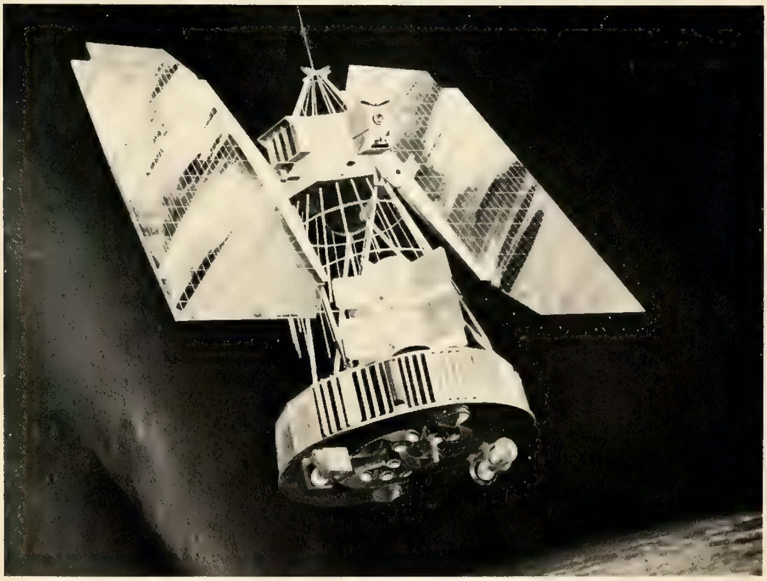
The system automatically gives the pilot an up-to-the-minute picture of his position in the air, the glide capability of his craft, and the distance and procedures he must follow to land safely.

Bikle and John S. McCollum, director of new programs and research projects in the Air Force Aeronautical Systems Div., also reviewed the past record of the *X-15* program. The officials said that the *X-15*, which has made 150 successful flights since June, 1959, has more than doubled the limit of manned flights in winged vehicles.

Speed has been increased from a little more than 2,000 mph to more than 4,100, and higher-velocity flights are planned. Design specifications called for the *X-15* to reach altitudes of up to 250,000 ft., but it has reached 354,200 ft. ■

New Drawing Depicts Nimbus B with SNAP Unit

ARTIST'S CONCEPTION of NASA's Nimbus B meteorological satellite, third in Nimbus series, with SNAP 19A installed atop sensory ring. SNAP 19A, a 50-watt radioisotopic thermoelectric generator (RTG), is designed to assess operational capability of radioisotopic power for weather satellites. It will augment solar-power conversion power supply on Nimbus B, planned for launch in 1967-68.



DDR&E Reorganization Nears Finish

Sullivan's new office is measure of growing tactical emphasis; two appointees may be needed to fully replace retired Fubini

REORGANIZATION of the Directorate of Defense Research and Engineering (DDR&E) is now expected to be complete within the next two weeks.

Most recent appointment in the reshuffle begun last month (M/R, Sept. 13, p. 14) is that of Leonard Sullivan to the new assignment of assistant deputy director of tactical systems review and analysis. This reflects DDR&E's emphasis on tactical warfare missiles and systems. Sullivan, formerly assistant director for combat systems, will spread his effort over the entire directorate of tactical warfare programs and will have charge of all review and analysis of new programs. He will report to Thomas R. Cheatham, Jr., deputy director of tactical warfare programs.

- **Filling Fubini's shoes**—Insiders say it actually may take two men to replace Dr. Eugene Fubini, who left DOD on July 15 to take a position with International Business Machines Corp. The highly regarded Fubini, who held the title of deputy DDR&E director and Assistant Secretary of Defense, will be replaced by what planners call a "senior deputy director." But these same informants told MISSILES AND ROCKETS that, depending on who the replacement is, it may be necessary to create an additional deputy directorship—probably in a technology area, to fill any gaps left in the directorate's top-level technical competence.

In addition to Sullivan's appointment, other new assignments in Cheatham's deputy directorate include those of Thomas C. Muse as assistant director (tactical warfare systems); Melvin Bell, assistant director (tactical missiles and ordnance); and J. K. Nunan, assistant director (sea warfare systems). Assistant director for tactical control and surveillance had not been named as of the middle of last week.

Bell and Muse are working in the same areas to which they were assigned prior to the reshuffle, but will now handle systems aspects of those areas that were formerly dealt with by Sullivan.

Sources say the tactical warfare programs group had been "considerably overworked" and that the reorganization is aimed at relieving that situation.

The first phase of reorganization, in early September, saw the elimination of the deputy directorate for space, after its chief, Dr. Albert C. Hall, returned to the Martin Co. The space office was put under the direction of Daniel J. Fink, formerly deputy director for strategic and defensive systems, and combined into a new deputy directorate for strategic and space systems. A new deputy directorate for electronics and information systems was established under Thomas F. Rogers, who had been an assistant deputy director (communications and electronics) under Chalmers W. Sherwin, deputy director for research and technology.

- **New lineup**—DDR&E now is composed of these deputy directorates: administration and management, headed by Lt. Gen. William J. Ely; electronics and information systems, under Rogers; research and technology, under Sherwin; strategic and space systems, under Fink; and tactical warfare, under Cheatham.

Ely's office is practically unchanged apart from the recent addition of administrative assistant J. Russell Johanson. In the office of the deputy director for electronics and information systems, Rogers for the time being will serve as his own assistant director for communications and electronics. R. H. Scherer, who earlier worked in Fink's group as head of strategic command and control, is now head of command and control under Rogers. Dr. Sam Koslov will also be working in Rogers' group as assistant director (intelligence and reconnaissance). On some matters, however, he will continue to function as special assistant to the directorate of DDR&E for intelligence and reconnaissance. ■

Douglas Issues 44 Requests for MOL Bids

REOPENING OF SUBCONTRACT competition for the Air Force's *Manned Orbiting Laboratory* by Douglas Aircraft Co., prime contractor, has resulted in 44 requests for proposals issued by Douglas last week on four of the major *MOL* subsystems.

The 44 bids involve 22 different companies. All proposals made in response to the RFP must be in this month, according to the firm. The subsystems involved include communications, data management, navigation, and attitude control. The three major members of the Douglas proposal team on *MOL* in these areas—Sperry, for attitude control; Collins Radio, for communications; and IBM, for data management, guidance, and navigation—are all on the new RFP list.

Sources close to the *MOL* project told MISSILES & ROCKETS that they did not contemplate any further competition in these areas after the current round of proposals is received and evaluated. They added that awards are expected three or four weeks after proposals are submitted, placing estimated contract dates late in November, according to current plans.

Douglas had earlier initiated competition on two other *MOL* subsystems, a fuel-cell power supply and the environmental control and life support systems. RFP's for these went out in May, prior to the actual award of *MOL* to Douglas. Allis-Chalmers, GE and Pratt & Whitney are competing for the fuel-cell contract. Hamilton Standard Div. of United Aircraft is vying with the AiResearch Div. of Garrett Corp. for the environmental and life support systems.

Eleven firms were invited to bid on the communications system. These include RCA, Collins Radio, Philco, Hughes Aircraft, TRW Systems, ITT, ECI, GE, Northrop, Motorola, and IBM.

For data management, RFP's went to RCA, Hughes, IBM, Raytheon, TRW Systems, Honeywell, Litton, Univac, Autonetics, General Precision, Inc., and Nortronics.

Twelve firms received invitations to bid on the navigation system. They are Hughes, IBM, Autonetics, Sperry, GPI, AC Spark Plug Div. of General Motors, TRW Systems, Raytheon, Nortronics, Honeywell, Bendix, and American Bosch Arma Corp.

Ten firms were invited to bid on the attitude control system. These include Bendix, Sperry, Honeywell, GPI, America Bosch Arma, Autonetics, TRW Systems, RCA, Northrop, and IBM.

Scramjet Tests Showing High Promise

IDA report at Society of Automotive Engineers meeting confirms early optimism; other reusable vehicles studied

Los Angeles—Optimistic theoretical predictions for the performance of the supersonic combustion ramjet (Scramjet)—at least in specific test conditions—have been fully confirmed by experiments to date, reports the Institute for Defense Analyses (IDA).

The Air Force's Scramjet program (M/R, Sept. 13, p. 15; Sept. 27, p. 21) has been launched with a $5-million contract to Marquardt Corp., which has teamed with General Applied Science Laboratories and Lockheed-California Co. Test flights with a solid booster are planned at Western Test Range, Vandenberg AFB, Calif.

IDA engineers Roberto Vaglio-Laurin and Reinald G. Finke discussed Scramjet's potential in an analysis of reusable space launch vehicle (RSLV) concepts at a meeting of the Society of Automotive Engineers here.

They noted that a Scramjet module has been successfully operated in a tunnel under simulated Mach 6 flight conditions, and that free-flight demonstration in the same velocity range is expected within about a year.

They said there have been varying estimates of Scramjet fuel specific impulse at high Mach numbers, but that these can be attributed to different assumptions as to component efficiencies and feasibility of various modes of injection. "Present realistic evaluations indicate efficiency levels sufficiently high to justify the more optimistic performance projections."

• **Four vehicles compared**—The IDA presentation, a progress report on an RSLV study under way at the Pentagon agency, was mainly devoted to an assessment of several of the technologies involved. It compared four vehicles: a vertical-takeoff/horizontal-landing vehicle with rocket first and second stages (a *Titan III-C*); a horizontal-takeoff/horizontal-landing (HTOHL) vehicle with hydrogen airbreather first and second stages; an HTOHL with hydrogen breather first stage and rocket second stage; and an HTOHL with ethane airbreather first stage and rocket second stage.

The report said results of the comparison showed that a 10,000-lb.-payload reusable HTO vehicle with an airbreathing first stage and a rocket second stage is very attractive operationally and economically, but a Scramjet second stage to orbit is relatively unattractive from a cost standpoint.

"Mixed HTO and all-rocket VTO vehicles exhibit total 10-year program costs that do not differ by more than 10% for realistic launch rates. The 10-year program costs of the reusable systems considered will be greater than those of existing boosters at a traffic rate of 300,000 lbs. of payload to orbit per year, but doubling the traffic rate would make it possible to justify the development of reusable vehicles on an economic basis alone. Reusable vehicles are always significantly less expensive if research and development costs are excluded. The aerodynamic heating and materials problems are less critical than suggested in previous studies."

• **Martin Co. confident**—Another RSLV report, by Martin Co.'s Denver Div., said there was ready economic justification for a manned, maneuverable re-entry vehicle. "If as few as 125,000 lbs. of $5,000/lb. payload are recovered annually by 1975," it said, "the re-entry vehicle can return a $5-billion net savings by 1980. The system is economically feasible if as little as a $125-million value of payload is recovered annually by 1975." ■

Martell Warns of ASW Deficiencies

THE NAVY'S TOP EXPERT on anti-submarine warfare has called upon industry to remedy ASW deficiencies in an effort to offset the increasing threat from a large Soviet submarine force.

The Soviet Union is continuing to strengthen and upgrade its submarine fleet and is adopting new undersea tactics, according to Vice Adm. Charles B. Martell, director of anti-submarine warfare programs for the U.S. Navy.

"A war at sea is a possibility which we must be ready to counter," he informed a Washington meeting of the American Institute of Aeronautics and Astronautics last week.

The admiral said Soviet interest in, and operations on, the high seas are steadily increasing. In the past year, he declared, the Soviets have made a clear decision to operate their submarines quite differently.

"The Soviets are operating more and more extensively outside of the Bering Sea, the Baltic, and the Black Sea, which have been their normal exercise areas," the ASW director said. "They are maintaining a few submarines in the Mediterranean at the present time and have been for more than a year. They have also greatly increased the scope of submarine participation in their annual fleet exercises in the Norwegian Sea."

A significant proportion of the Russian submarines are nuclear-powered, with greatly increased capabilities and a potential of underwater launch of ballistic missiles, he said.

The Navy's top ASW advocate also asked the industry to work on ASW deficiencies which he said "are really crying for attention." Among these he listed: inadequate design for reliability, inadequate design for maintainability, poor configuration control, poor application of what is known of signal-processing techniques, insufficient integration of equipment with ship design, inadequate checkout of systems when first installed, and poor quality control.

Until a year ago, quality control on homing torpedoes was so poor that proof testing was necessary on almost 100% of every production run, the admiral said. Emphasis on this area has brought a drastic improvement, he declared.

"If I can sell any one particular thing to you gentlemen in industry today, it is the need for quality," the Navy ASW director said.

Martell also stressed the need for simplicity—"first, to avoid costly complexity except where absolutely necessary; second, and I personally feel of greater importance, to better ensure continued operation with a minimum of effort. The average young Navy bluejacket must be able to maintain these equipments at sea."

Eight Saturn IB, V Launches Set

Program includes tests to qualify Apollo re-entry heat shield; first manned mission scheduled for early 1967

SPACE AGENCY OFFICIALS have revealed a detailed schedule that calls for eight launches of the *Apollo* spacecraft through 1966 and part of 1967 in the *Saturn IB* and *Saturn V* booster programs.

The first *Apollo* spacecraft to be launched from Cape Kennedy in the *Apollo* series will be delivered "within two weeks" at the earliest.

Delivery of the instrumented Command and Service Modules was originally slated for late September. The delay may have seriously altered plans to launch the mission within this year—an unofficial date.

- **The first shot**—The unmanned spacecraft will be launched on a ballistic path by a *Saturn IB* launch vehicle, accelerated downward after reaching the peak of its trajectory, and rammed back through the atmosphere to qualify the heat shield under a moderately high-speed re-entry. The additional 3,000 fps to increase re-entry speed to 29,000 fps will be provided by burning the Service Module's engine for approximately 200 seconds.

The second *Apollo* mission (*Saturn-Apollo 202*) in early 1966 will be a ballistic lob shot to an altitude of 650 n. mi. for a "super circular" re-entry trajectory, with splashdown programmed near Wake Island in the Pacific Ocean, MISSILES AND ROCKETS has learned.

The near-lunar re-entry speed will be augmented by a three-minute burn from the Service Module propulsion system to achieve a speed in excess of 28,000 fps for an evaluation of the Command Module heat shield.

Apollo planners also hope to try several restarts of the Service Module engine and to collect data on sequencing leading to separation of such large components as the launch escape system tower, the Command and Service Modules and the adapter housing for the Lunar Excursion Module. The *SA-202* spacecraft will have all systems on-board, including the Pratt & Whitney fuel cells, a Manned Spacecraft Center spokesman said.

- **Propellant behavior probed**—*SA-203* will be flight-rated by Marshall Space Flight Center. The mission will be designed to study venting effects of LOX and LH_2 (liquid oxygen and liquid hydrogen) from "boil off" as a consequence of aerodynamic heating during launch and absorbed solar radiation in orbit.

The boil-off rate of cryogenics kept at —473°F will be limited to the length of time the *Apollo* spacecraft can orbit Earth before committing its crew to the translunar "kickout." Jet effects of venting may affect spacecraft attitude and trajectory prior to the critical kickout.

Saturn-Apollo 204 may be the first unmanned orbital mission, depending on the results obtained from the earlier unmanned, suboribital flights. *SA-204*, which will use a complete spacecraft with all systems on board, is scheduled for the latter part of 1966.

Saturn-Apollo 205, the earliest manned mission, is programmed for early 1967. *Apollo* planners hope to follow this mission with two unmanned Block II *Apollo* spacecraft flights using the *Saturn V* vehicle. *SA-501* and *SA-502* will be ballistic shots to qualify the lunar heat shield under a full-velocity re-entry of 36,000 fps, M/R was told.

SA-207, the first evaluation flight of the Lunar Excursion Module, is also scheduled for 1967. ■

Apollo Applications RFP Hits Snag

Requests for proposals for systems definition of payload integration of the *Apollo* Applications program scheduled to be issued Oct. 15 has now been delayed, perhaps by as much as 30 days.

Poor preparation work statements by the Marshall Space Flight Center—which will direct the program—and a lack of final program approval by NASA Headquarters is forcing the delay, informed sources report.

In a related development, a decision on the reorganization of the *Voyager* program was pending last week as top management officials continued to work on preparation of the agency's Fiscal Year 1967 budget.

The Bureau of the Budget reportedly has told NASA to keep its request for the next fiscal year below the $5.25 billion level of FY '66. Thus far, the space agency is fighting hard against this ceiling, and, while its position has not been approved as yet, the Budget Bureau has not slammed the door completely to some sort of compromise solution.

Space agency officials believe that any figure much below this year's would cut funding levels for *Apollo* Applications to well below the $200 million they feel is needed next year if any sort of meaningful program is to be started.

Although it has not yet been officially announced, Marshall has been given field center responsibility for the payload integration of AA (M/R, Sept. 27, p. 14).

Final approval of the selection of Marshall by top NASA management is expected shortly. Then, if its budgetary problems can be worked out, a go-ahead for the RFP is also expected.

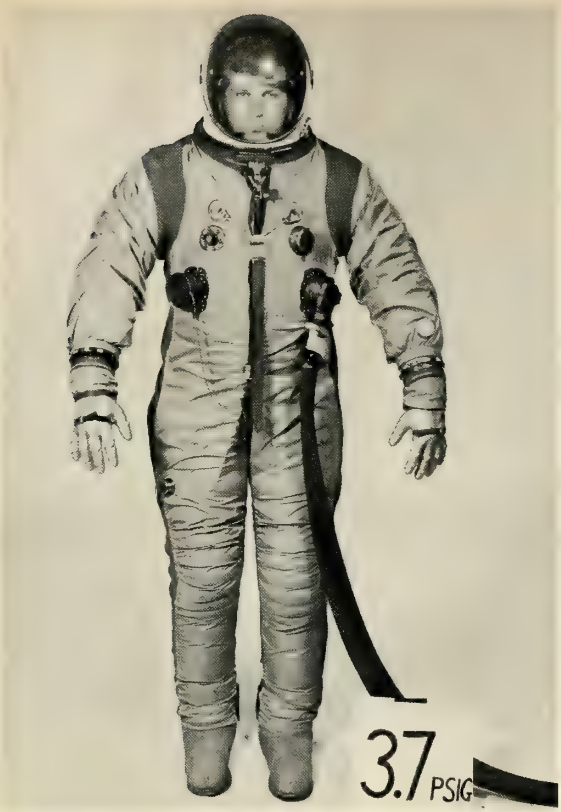
Dr. Wernher von Braun, director of MSFC, recently reported that Marshall is ready to handle the program if the job is assigned to the center. He said that work is well along on the *Saturn* stages and engines and the momentum of industrial facilities will have to be cut back.

An *Apollo* Applications group totaling a few hundred persons has been set up in MSFC's Advanced Systems Office under the direction of Dr. P. J. deFries.

Von Braun also indicated that he thought flights of *Apollo* Applications hardware could begin in 1969 after the lunar landing is accomplished. NASA official plans, however, still call for one AA flight to be made before U.S. astronauts set down on the Moon.

The *Voyager* reorganization reportedly calls for scrapping the *Saturn IB-Centaur* launch vehicle and replacing it with the *Saturn V* (M/R, Oct. 4, p. 14). This would permit a *Voyager* payload of close to 50,000 lbs. to be sent to Mars in the 1971 and 1973 launch opportunities.

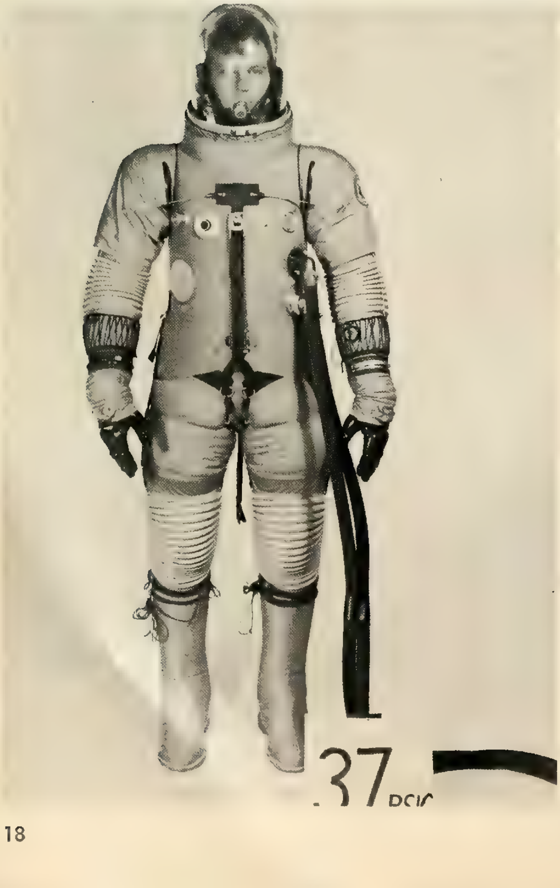
Three Entries Vie For Apollo Lunar Suit Selection

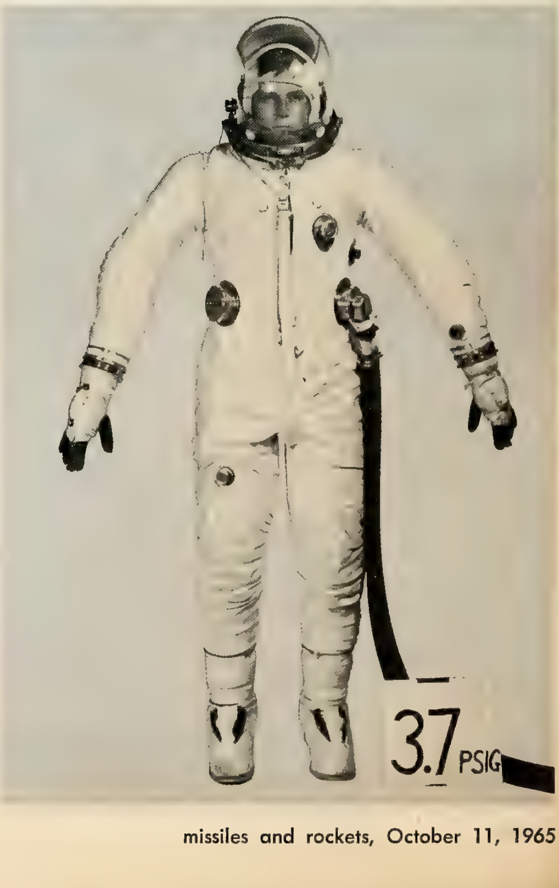


NASA'S MANNED SPACECRAFT CENTER is evaluating three spacesuit designs for *Apollo* Block II (lunar mission) flight wear.

Hamilton Standard, of Windsor Locks, Conn., a division of United Aircraft Corp., together with B. F. Goodrich Aerospace and Defense Products Div. is proposing the design at left. HS, earlier named prime *Apollo* suit contractor, terminated its subcontract with International Latex Corp. at the beginning of this year and negotiated a new contract with Goodrich. In the meantime, International Latex has submitted its own design, shown at bottom left. A third proposal, by David Clark Co., of Worcester, Mass., is shown below.

David Clark Co. already has the contract for development of the modified *Gemini* spacesuits that will be worn by *Apollo* crews flying Block I (Earth-orbital) missions.





Big Solids Cancellation Resisted

Air Force hopes to keep 156-in. motor program alive, fund studies of pure solid launch system with $12-million request

by John F. Judge

AIR FORCE EXPERTS and the solid propellant industry are fighting a Defense Dept. decision to eliminate the 156-in. solid motor program from the Fiscal Year 1967 defense budget.

If the present situation prevails, the only large-solid program left in the U.S. will be NASA's low-level effort on the 260-in. motor—a program with little military potential and already in budget difficulties.

Space Systems Div. of Air Force Systems Command has requested a solid program in FY 1967 totalling $12 million. Half would go for an investigation of 156-in. solids as zero-stage strap-ons and the other $6 million would fund studies into a new all-solid launch system.

At least two test flights are envisioned in the request—a tethered pop-up from an *Atlas-F* silo and a short, 100-mi. shot. Both were designed to provide information obtainable only from such a dynamic test program and were not aimed at any specific missile or booster vehicle application.

The present 156-in. program has been completely successful to date. Air Force contractors have come in under 3% overruns on fixed-price funding meeting all objectives in the test firings.

The only unfunded portion of Program 623A left is the loading and firing of a segmented reinforced plastic case designed by Thiokol Chemical Corp. and built by B. F. Goodrich Co. This case passed its hydrotest two weeks ago.

- **Funds dwindle**—The present funding covers programs at Thiokol and Lockheed Propulsion Co. Thiokol is well on its way to completing Bid Package 15, a 156-in. plastic-cased, nearly spherical solid motor. This is to cost about $2.5 million through test firing.

Lockheed has about $5.5 million for the building and test firing of two motors. One is a segmented motor some 75 ft. long containing 700,000 lbs. of propellant and rated at a thrust level of 3 million lbs.

The second LPC unit is a monolithic motor 33 ft. long designed to develop 1 million lbs. thrust. Both will have been fired by early 1966. There is no money in FY '67 for any of these programs.

The decision to use seven segmented 120-in. solids as the zero-stage on the *Titan III-C Manned Orbiting Laboratory* launch system eliminated the possibility of 156-in. units for that application in the near future.

The overall 623A program also included work on thrust-vector-control systems but very little in the way of directing these motors to a flying system.

- **ICBM data slim**—Should the programs be eliminated from FY '67 funding, the Air Force is left with extrapolations of first-stage *Minuteman* flight data for any future solid ICBM program. The large-solid program involved only static test firings with very little data on the dynamic environment involved in launching such huge systems.

Program 623A kept well within the state of the art in propellants and nozzle designs. Even the thrust-vector-conrol work can be considered as somewhat less than advanced except for sheer size and weight.

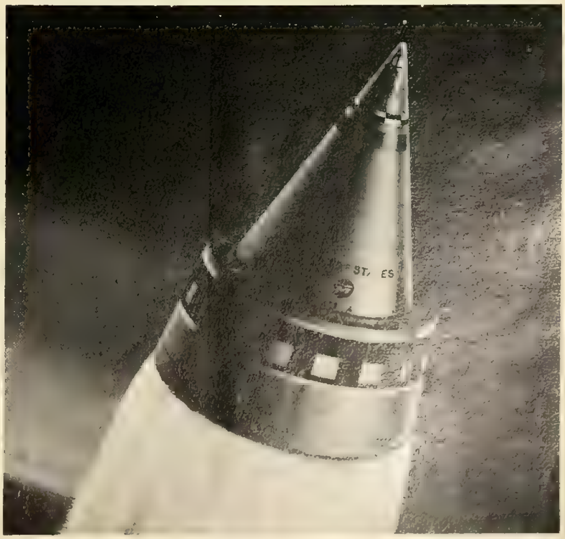
Propulsion experts never tire of pointing out the enormous difference between an engine and a stage—either liquid or solid. The large-solid programs to date have essentially been motor efforts—even though the last set of projects covered flightweight hardware.

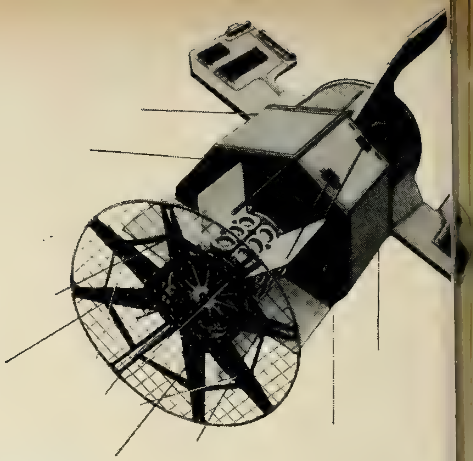
The Air Force attempt to fund dynamic testing over the next two fiscal years is being viewed pessimistically by industry observers. The 623A program may yet emerge in the FY '67 budget as a very-low-keyed technology program aimed at raising performance levels and cutting costs but without any major forward step in the development of a realistic large solid launch system.

If not, the solid rocket may well have been dealt a mortal blow and industry experts foresee the dilution and eventual disappearance of a highly successful technology. ■

RENE Propulsion Studies Funded

MARTIN-DENVER will build full-scale missile models using solid propellants and the firm's Rocket Engine Nozzle Ejector (RENE) concept (M/R, June 29, 1964, p. 16) under a $1.2-million contract awarded by the Air Force. The RENE system employs a shroud around the engine nozzle. This shroud collects air during flight, and feeds it into the engine exhaust at a predetermined rate while controlling expansion of mixed exhaust gases. Prototype propulsion models will be tested at Martin-Denver and at the Air Force Arnold Engineering Development Center Rocket Propulsion Lab.





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Technical Countdown

ELECTRONICS

Active Optics Developed for Space Observatory

A unique "active" optical design for large optical telescopes will be used by Perkin-Elmer Corp. for use in manned or unmanned space stations. The method will provide for the formation of a single, large, diffraction-limited mirror in space by positioning and automatically aligning several individual optical segments. Performance of the diffraction-limited optics is bound only by the laws of physics. Perkin-Elmer will develop the instrumentation required for extremely accurate measurements and continuous alignment of the critical optical segments in the first phase of the $175,000 NASA contract. The firm will also build a scaled-down version of the spherical segmented mirror for a design feasibility testing program. Later phases in the long-range program will cover the consideration of building, testing and launching space telescopes with mirror diameters of 100 in. or more.

Minuteman Electronics Hand Portable

Microelectronics has enabled shrinking of the start-up and targeting equipment for *Minuteman II* to the point where the ground equipment can be carried by one man instead of a van, Autonetics division of North American Aviation reports. The electronic equipment has been incorporated into two hand-portable cases.

MATERIALS

Million Pound Calibration Operational At NBS

Three huge deadweight machines—1 million-lbs., 300,000 lbs. and 112,000 lbs.—are in operation at the National Bureau of Standards Engineering Mechanics Lab at Gaithersburg, Md. The force-measuring devices apply loads in tension or compression to calibrate large force-measuring instruments. The new machines reduce calibration times by almost half and with accuracies 10 to 50 times as great as previously possible. The units have an uncertainty of 0.002%—or 20 lbs. at 1,000,000 lbs. The machines will save the space program hundreds of millions of dollars in the development of rocket engines, since fewer thrust-measurement tests will be required.

Isolated Lab Working at North American

A new 20,000-sq.-ft. metrology laboratory has been placed in full operation by Autonetics division of North American Aviation. The facility is built on top of some 5,000 ft. of sand to provide damping of ground vibrations. Each of its 26 laboratories is designed to minimize effects of seismic disturbances, temperature changes and electromagnetic interference.

Radiation Calibration Method Perfected

An electron gun method of vaporizing radioactive uranium and depositing it on polished stainless steel in layers 50 to 150,000 Angstroms thick has been developed at Aerojet-General Nucleonics, San Ramon, Calif. Steel discs so treated are used to study patterns made by fission fragments escaping from the film under irradiation treatment. The technique also can be used to provide radioactive sources for instrumentation calibration.

Metalworking Data on Titanium Alloy Available

The Air Force Machinability Data Center has published AFMDC 65-1, *Machining Data for Titanium Alloys,* which updates data reported in the USAF Machinability Report, Vol. 3 (*Titanium*). Copies are available at $1.50 each from the center at 3980 Rosslyn Drive, Cincinnati, Ohio, 45209; Attn: Mrs. Mary K. Niland. Discount prices are available on quantity orders. Information services of the center are also available without charge to the aerospace industry, technical institutions and government agencies. The service covers the machining of all materials and both the material and the machining operation should be identified in the request. All details concerning present practices should be included. Company names will be kept confidential but the data developed remains the property of the Air Force and will be disseminated for similar queries.

LIFE SUPPORT

Apollo-Type Undersuit Viewed by Navy

The water-conditioned suit developed under the direction of Dr. John Billingham of NASA's Manned Spacecraft Center for cooling *Apollo* astronauts also has application of interest to the Navy in supplying heat to immersed personnel, Navy doctors report. Billingham tested the suit under a 3/16-in. unicellular foamed diver's wetsuit in 4°C water for more than an hour, maintaining his body temperature by using an inlet water temperature of 45°C and a mean flow of 3.8 liters of water per hour. Since the liquid is incompressible and the tubes are relatively rigid, Navy researchers say, the pressure drop in the tubing is not affected by immersion as would occur in a suit dependent on airflow. A number of heating systems, one chemical, hold promise for use with the suit.

Altitude Increases Effort

Findings in a new high-altitude research program at University of California's White Mountain Research Station show men "try harder" when they feel the physiological stresses resulting from lack of oxygen, and, in some cases, actually attain better test scores than at sea level.

SPACE SCIENCE

Science Poor Relative of Space Effort

Dr. Willard F. Libby of UCLA urges a program to put more science into space exploration, declaring "science has been the lesser part of the effort." Libby, head of the Institute of Geophysics and Planetary Physics and the institutes's Space Sciences Center, points out "the dominant factor so far in the manned space program has been the drive to establish good engineering technology." He suggests three major steps to correct this: establishment of a six-man scientific task force by NASA, which would work and live for a year with the astronauts in training, close co-operation and balance between scientific research at the best universities and between engineering effort at aerospace industries and NASA facilities, and a mutually-happy "marriage" between space and education to attract and inspire students.

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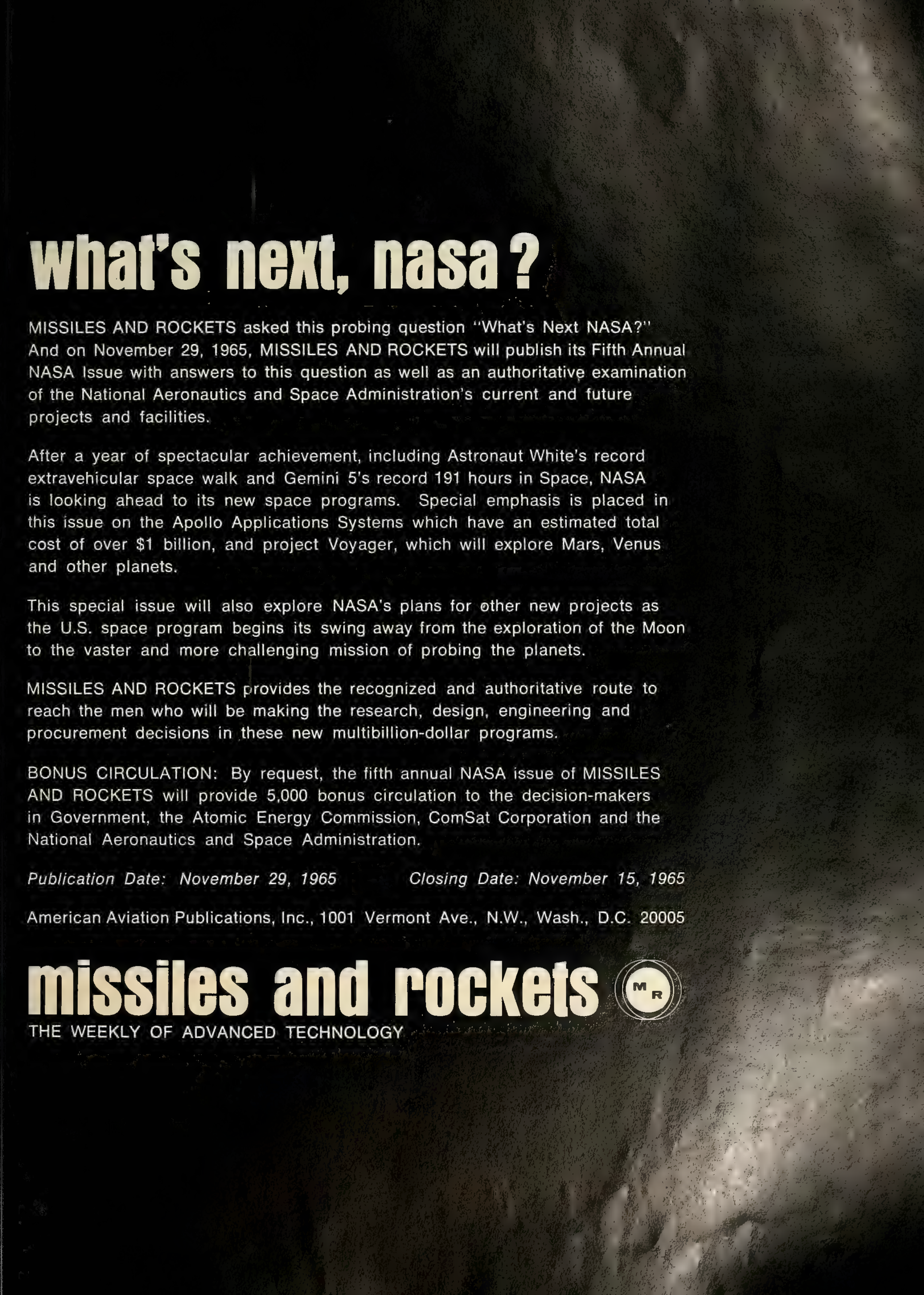

what's next, nasa ?

MISSILES AND ROCKETS asked this probing question "What's Next NASA?" And on November 29, 1965, MISSILES AND ROCKETS will publish its Fifth Annual NASA Issue with answers to this question as well as an authoritative examination of the National Aeronautics and Space Administration's current and future projects and facilities.

After a year of spectacular achievement, including Astronaut White's record extravehicular space walk and Gemini 5's record 191 hours in Space, NASA is looking ahead to its new space programs. Special emphasis is placed in this issue on the Apollo Applications Systems which have an estimated total cost of over $1 billion, and project Voyager, which will explore Mars, Venus and other planets.

This special issue will also explore NASA's plans for other new projects as the U.S. space program begins its swing away from the exploration of the Moon to the vaster and more challenging mission of probing the planets.

MISSILES AND ROCKETS provides the recognized and authoritative route to reach the men who will be making the research, design, engineering and procurement decisions in these new multibillion-dollar programs.

BONUS CIRCULATION: By request, the fifth annual NASA issue of MISSILES AND ROCKETS will provide 5,000 bonus circulation to the decision-makers in Government, the Atomic Energy Commission, ComSat Corporation and the National Aeronautics and Space Administration.

Publication Date: November 29, 1965 *Closing Date: November 15, 1965*

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missiles and rockets MR

THE WEEKLY OF ADVANCED TECHNOLOGY

$.5 Billion/Year Market Possible Result Of Planned High-Energy Physics Effort

by William S. Beller

ALL SIGNS INDICATE that a national program in high-energy physics will start during the next Government Fiscal Year, which opens July 1, 1966. Experts predict that its annual cost will reach half a billion dollars within a decade, and many segments of the missile/space industry will be involved in the work.

A keystone in this program is the 200-billion-electron-volt (Bev) accelerator, a facility that will cost nearly $350 million to build and equip but whose site is yet to be chosen. "About half this money will be associated with hardware," estimates Dr. William Wallenmeyer, the Atomic Energy Commission's acting assistant director for high-energy physics programs.

Much of the hardware undoubtedly will interest firms in the fields of vacuum technology, computers and data reduction, and those able to supply electronic parts and controls, power supply systems, and large magnetic structures. Moreover, some of the construction work itself might draw bids from companies that have directed and built ground-support complexes for missile/space projects.

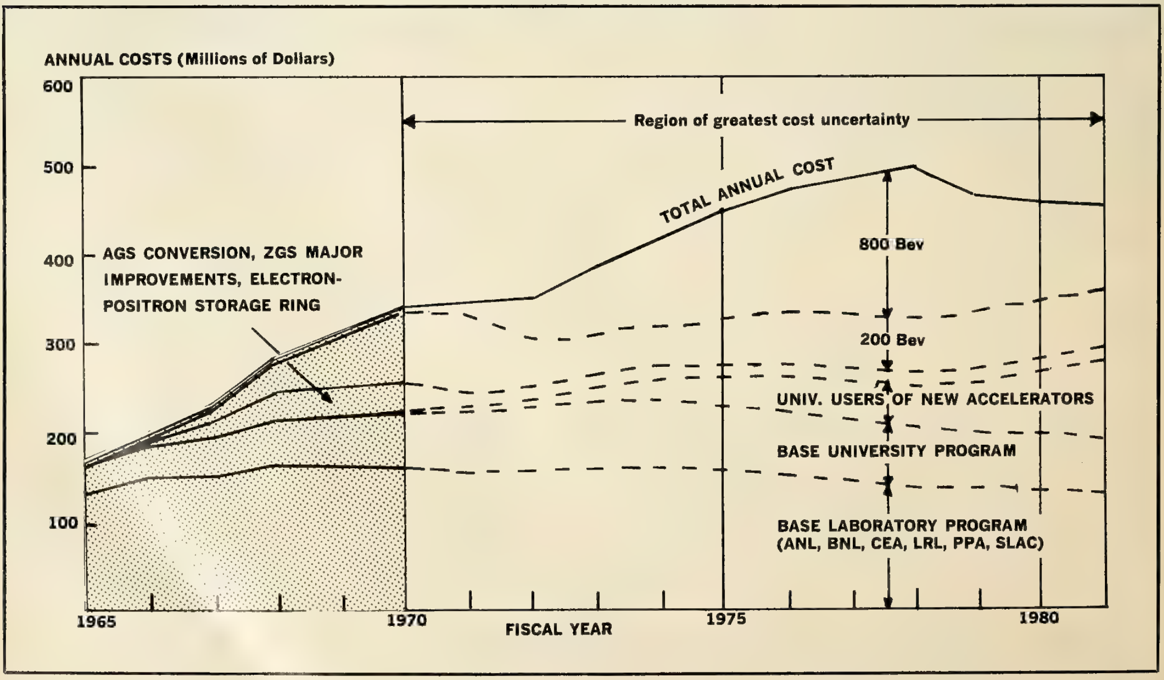
Scientists and Administration officials concerned with high-energy physics are even now looking a step ahead of the 200-Bev accelerator to a 600-1,000-Bev unit, which they suggest the Federal Government might authorize in Fiscal 1971.

Meanwhile, they are calling upon Congress for "support for the development and utilization of new and improved techniques and methods of particle detection and data reduction and analysis, including the strong need for advanced computational facilities." This is one of several suggestions made by the AEC earlier this year in a report on "Policy for National Action in the Field of High Energy Physics," prepared for the Joint (Congressional) Committee on Atomic Energy.

Other suggestions included updating the major U.S. accelerator facilities already in operation, particularly at the Argonne and Brookhaven National Laboratories; studying new accelerator principles and techniques; and getting rid of accelerators that have become "relatively unproductive."

● **Management by universities**—There is little doubt that the recently formed University Research Associates, Inc. will manage the 200-Bev and larger national accelerators once they are built. Set up specifically for this purpose and made up of a score or so of the nation's leading universities, the organization

ESTIMATED ANNUAL costs of national program in high-energy physics.



may also become the prime contractor in building the 200-Bev accelerator, although it is also possible, according to Walter Hughes, AEC's assistant director for administration, that it may be only one of a number of primes.

The forming of a group of universities to run a national laboratory has worked out very well with Brookhaven, which is managed by Associated Universities, Inc., a combine of major Eastern universities. The latter supplies a precedent for the new group, which has a nationwide geographic base. Oddly enough, the new organization is not yet recognized officially by the AEC. "But we've had no objection to their existence or goals," Hughes told Missiles and Rockets, and he indicated the organization probably would be called upon at the appropriate time.

The AEC undoubtedly will be systems manager for the 200-Bev accelerator, judging from past experience. The agency will do the major integration work, but will designate primes for all or parts of the construction work and for all equipment systems and subsystems. If the site chosen is anywhere near Oak Ridge, Tenn., where the AEC has strong engineering support, then the construction itself undoubtedly will be managed by the Commission, which would name appropriate subcontractors, "thereby saving the general contractor's fee of 10%," an AEC spokesman pointed out.

The schedule outlined in a design study by the Lawrence Radiation Laboratory, University of California, calls for the accelerator to be operating 6½ years after construction authorization, and the physics research program to begin 7 years after authorization.

- **Money awaited**—Despite an 8-lb. "200-Bev Accelerator Design Study" prepared this summer by the Laboratory, and earlier background reports written for the Government by select panels and committees to justify the need for more high-energy research and its hardware accouterments, Congress so far has neither appropriated nor obligated money for this project.

The starting gun is expected to be fired by the President in his January budget message, when he probably will recommend spending \$5-\$10 million to design the 200-Bev accelerator in detail, with a view of starting construction in Fiscal Year 1968. This is in line with AEC's recommendations and the sentiment of the Joint Committee on Atomic Energy.

Pressure is strong for selection of a site for the 200-Bev unit before the end of this year, lest the project be delayed. This would also make it possible for the President to name the site in his next budget message to Congress, and for the AEC to design the foundation of the accelerator.

The urgency of the project stems from the increased activity of the Soviet Union in the accelerator field. Until now, U.S. high-energy physicists have had the world's best facilities. Partly as a result of this, most of the world's major high-energy physics developments and discoveries have been made in U.S. laboratories.

Several of these accomplishments were recognized by the award of Nobel prizes: "Nonconservation of Parity in Weak Interactions," Chen Ning Yang and Tsung Dao Lee, 1957; "Discovery of Antiproton," Emilio Segre and Owen Chamberlain, 1959; "Electron Scattering and the Structure of the Nucleon," Robert Hofsadter, 1961.

At Brookhaven, the present site of the world's most powerful accelerator, a 33-Bev unit has been operating since 1960. Next largest is the 28-Bev proton accelerator which has been operating since 1959 at Geneva, Switzerland, under a cooperative European venture known as CERN.

On the other hand, the largest Soviet unit is a 10-Bev synchrotron at Dubna, near Tula. However, about 60 miles south of Moscow, at Serpukhov, Russia is building a 70-Bev proton accelerator, which is expected to be finished next year, and operating in 1967. Under the present timetable, this machine will give the Soviet a monopoly on the world's most powerful proton accelerator for six years.

The scientific community regards discoveries in high-energy physics as at least equal in importance to those in space exploration, and it is in the former realm that many U.S. physicists are fearful they may have to take a back seat to the Russians for years to come.

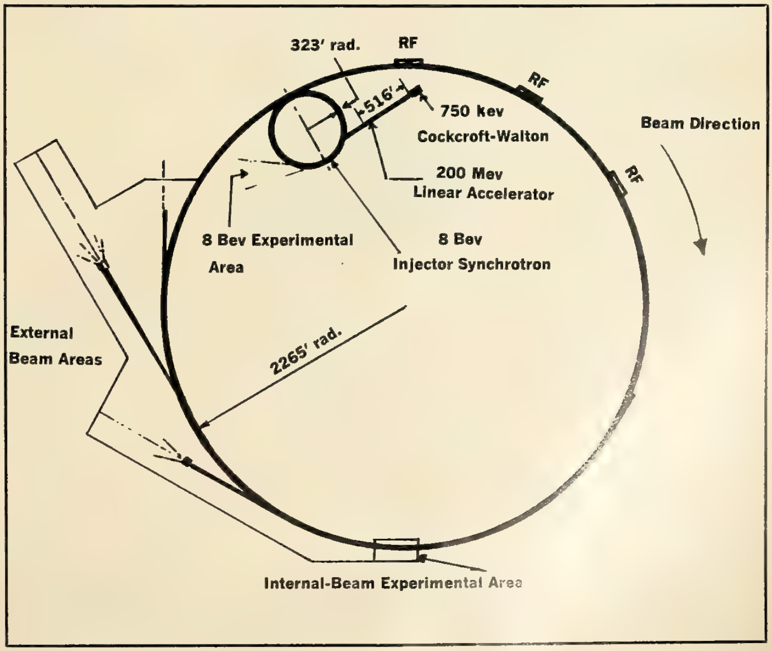
- **Political factors**—Meanwhile, political considerations have entered into the choice of the site for the 200-Bev unit. Nearly every township in the country that can boast a recognized college or university is bidding for the accelerator —and the new industrial activity and prosperity expected to accompany it. This expectation is based on experiences of communities where Federal space centers have been located, on the \$60-million estimated annual operating cost for the accelerator, and on the influx of from 2,000 to 3,000 highly trained scientists and engineers.

The National Academy of Sciences is trying to whittle down for the AEC the total of more than 100 applications for the accelerator site. This is a thankless job, earning for the Academy the resentment of some Congressmen who feel that their communities may have been eliminated without a thorough investigation.

There is a strong feeling, voiced by Rep. Craig Hosmer (R-Calif.), a member of the Joint Committee on Atomic Energy, that the facility should be placed either at Berkeley, Calif., near the Lawrence Radiation Laboratory, or at Brookhaven. He told M/R that if these centers of excellence for high-energy physics are deprived of the advanced accelerators, they would lose some of their top experts to a new location. This would "downgrade" the established facilities and dilute the national effort.

- **A four-stage affair**—Protons will

DIAGRAM OF 200 Bev accelerator.



Estimated Costs For 200-BEV Accelerator in Thousands of Dollars

SUMMARY BY MAJOR CATEGORIES

Estimated cost of project		
Apparatus and technical componets	81,230	
Physical plant (accelerator facility)	96,570	
General plant, utilities and support buildings	27,840	
		205,640
Engineering, design, inspection and Administration	20,310	
Architect and engineering fees	15,500	
Contingencies	46,360	
		82,170
Total, accelerator facility		287,810
Research equipment	40,500	
Escalation	19,650	
Total, construction project		347,960

COST BY FISCAL YEAR

Fiscal Year	Obligations	Costs
1967	35,000	8,000
1968	80,000	27,000
1969	100,000	55,000
1970	65,000	70,000
1971	40,000	75,000
1972	15,000	72,000
1973	7,960	33,960
1974	5,000	7,000
Total	347,960	347,960

COSTS OF SELECTED SUBSYSTEMS

Main-synchrotron magnet power supply		
Motor-generator sets (including primary switch gear and transformers)	2,900	
Power converters (including auxiliary supplies, bypasses, and ripple filters)	6,900	
Connections	900	
Subsystem controls and protection	500	
		11,200
Main-synchrotron vacuum system		
Vacuum chamber and sector valves	1,410	
High-vacuum pumping system	430	
High-vacuum pumping system power supply	170	
Forevacuum system	380	
Monitor and leak-hunt instruments	200	
		2,590
Injector-synchrotron magnet power supplies		
Capacitors	400	
Chokes	1,100	
Connections	100	
Power supplies and subsystem controls	400	
		2,000
Injector-synchrotron vacuum system		
Ring vacuum chamber and sector valves	530	
High-vacuum pumping system	210	
Roughing system	60	
Monitor, leak-hunt, and miscellaneous instruments	50	
		850
Injector-synchrotron RF system (24 cavities and 2 spares)		
Power amplifiers (including tubes)	780	
Driver system	440	
Power amplifiers power supplies	780	
Driver power supply	120	
AC line control	230	
Modulators	390	
Protective circuits	130	
Transmission lines	10	
Cavities, including ferrite	2,070	
Servo-control subsystem	230	
Energy storage	260	
Coupling and blocking capacitors	100	
Monitor	20	
		5,560
Linear accelerator		
Tanks and support	670	
Drift tubes	310	
Quadrupoles	110	
Quadrupole power supplies	150	
Steering magnet and power supply	50	
Magnet regulator subsystem	30	
Vacuum system	590	
Drift-space transport system	40	
Miscellaneous components	170	
Radio-frequency power amplifiers	850	
Modulators	500	
Energy storage	250	
Crowbar	100	
Main amplifier power supply	450	
Manifold, couplers, and loops	140	
Primes and power supply	130	
Prime manifold and coupling	70	
Crowbar, buncher, and debuncher	40	
Monitor and subsystems control	140	
		4,790
Accelerator control system		
Main-synchrotron controls (control devices, interlocks, cabling, racks, cable trays)	2,130	
Injector-synchrotron controls	470	
Multiplex systems	1,300	
Control computer (including display systems)	800	
Intercommunication and television	300	
Pickup-electrode system	230	
		5,230

COST OF RESEARCH EQUIPMENT

Transport and separation equipment	20,000	
Central computer	10,000	
Bubble chamber	6,000	
Data-reduction equipment	3,000	
Initial increment of counting equipment	1,500	
		40,500

be brought to 200 Bev in these four steps, if the recommendations of the Lawrence Lab are followed:

1) Protons will be generated in an ion source and accelerated to an energy of 750 kev in a Cockcroft-Walton pre-injector.

2) The particles will then be injected into an Alvarez-type linear accelerator and taken to 200 Mev.

3) The 200-Mev protons will be injected into a rapid-cycling "injector-synchrotron" and accelerated to 8 Bev.

4) The 8 Bev protons will be transferred to the main synchrotron. Seven successive 8-Bev beam pulses will be transferred to the main synchrotron in ⅓ sec. and stored in orbits around its circumference. During this injection, the magnetic field of the main synchrotron will be held constant, so that the 8-Bev protons circulate at constant radius until the circumference is filled. After filling has been completed, all the protons will be accelerated to full energy.

The Laboratory says that accceleration to 200 Bev will take place at a maximum rate of 30 cycles/min., or one acceleration cycle every two seconds. If desired, the magnetic field can be held constant at full energy to give a long beam pulse, which is desirable for many experiments. This "flat-top" has a maximum duration of 0.6 seconds; with this full flat-top the acceleration rate is 23 pulses/min., or one cycle/2.6 seconds.

• **Need for high energy**—The aim of high-energy physics, as with all science, is to reduce a large amount of observational data to a small number of simple laws. Thus, the "high energy" of high-energy physics is not an end in itself but a means to probe with a finely pointed tool into the structure of the nucleon. To do this with increasing skill requires increasing accelerator energies.

The present 25-30-Bev accelerators provide protons able to probe distances of the order of 10^{-14} cm. The laws of physics and the structure of matter for distances smaller than this are scarcely known, and then mostly through studies of the probings of cosmic rays.

By the same token, the laws are becoming fairly well known in the region of energies less than one Bev or distances greater than 10^{-14} cm, except for the basic question of the forces involved in a nucleon.

"For this purpose, it is necessary to extend the accelerator intensities beyond the . . . region in which most of the present-day machines operate," says the AEC in its national policy report. Reactions at the largest energies and momentum transfers that can be reached with a machine of a few hundred Bev will probe the strong interactions within nucleons at distances less than 10^{-15} cm, or about 1% of the size of the proton.

"Higher intensity, particularly of secondary particle beams, also is required for many experiments where higher intensity makes it possible to do research otherwise impossible (or too consuming of accelerator time)," asserts the AEC. ■

Infrasound Tests Human Tolerance

AMRL work important to design of booster static test, launch facilities; shows man can withstand very low frequencies

by Heather M. David

A SERIES OF TESTS of human tolerance to low-frequency and infrasonic noise conducted by Air Force scientists at the Aerospace Medical Research Laboratories (AMRL) at Wright-Patterson AFB, Ohio, has extended the range of human exposure to infrasound, and proven that short-duration exposure to low-frequency noise up to 150 db is within the human tolerance range.

The work done by Capt. George Mohr, Lt. Col. Elizabeth Guild, John Cole and Dr. Henning von Gierke is regarded as very important to the future construction of static-test and launch facilities for large boosters, as well as to the design of space capsules and astronaut protective gear.

The tests indicated decrements in visual acuity and interfering modulation of speech sounds which may have operational significance. In addition, there were observations of new respiratory and other physiological phenomena which will be studied further by the Air Force in the new Dynamic Pressure Chamber now nearing completion at AMRL.

- **Booster noise**—As the scientists point out, the large super boosters of the future will produce their maximum noise energy in the range below 20 cps, the infrasonic range. This noise will extend far from the launch site.

In the space cabin, this noise will diminish quickly, but as airspeed increases, aerodynamic noise will be generated by boundary-layer turbulence. At maximum dynamic pressure (max q), this will reach its highest level. In a recently published technical paper, the scientists point out that the larger the vehicle, the higher the aerodynamic noise level and the lower the frequency. For *Apollo*-size or larger vehicles, the peak frequency will be well below 100 cps.

Except for observations made by German physicians aboard submarines who observed changes in the diesel-room personnel, and later propeller energy exposures, there has been little documented experience with whole-body exposures to intense low-frequency noise.

In the AMRL studies, which began in mid-1963, five facilities were used to produce the whole range of noise exposure. The facilities included an AMRL High-Intensity Sound System, a turbojet engine, the NASA Langley Research Center Thermal Structures Tunnel, the Low-Frequency Noise Facility also at Langley, and the Low-Frequency siren chamber of the Sonic

Longest U.S. Space Cabin Experiment To Begin

THE LONGEST-DURATION space cabin experiment ever conducted in the United States is scheduled to begin this month at the Air Force's School of Aerospace Medicine. The two-month test is expected to help settle the decision on whether the *Manned Orbiting Laboratory (MOL)* should have a helium/oxygen or nitrogen/oxygen atmosphere.

Four air crewmen will spend some 60 days in the 30-ft.-long, 9-ft.-dia. *MOL* simulator at the Aerospace Medical Division headquarters, participating in other space-journey simulations during the period, and emerging around Christmas.

Aerospace Medical Division has been occupied recently with a number of simulator studies for both NASA and Air Force projects.

At the Aerospace Medical Research Laboratories, a recent two-week study has been completed on the acceptability of fuel-cell water for drinking. Eight college men who participated reported that the water is just as acceptable as distilled water.

The men ate four meals per day on a three-day menu cycle, with total water intake of about two quarts per day. Subjects were not told whether they were drinking distilled or fuel-cell water.

Caloric intake was about the same as that provided in astronauts' diets, and the men were restricted to hospital rooms at the Miami Valley Hospital in Ohio. The study was directed by Aerospace Medical Research Laboratory personnel for NASA in support of Project *Gemini*.

Another AMRL study simulated the high temperatures that might be experienced for long periods of time in a space capsule with a malfunctioning life support system.

Preliminary data show that a plentiful supply of water would be needed to combat dehydration, as evidenced by the four subjects' decreased urine volume and increased water consumption and perspiration rate.

The experiment, which lasted a total of 42 days, involved a 35-day confinement in a simulated spacecraft. Temperatures of 90°F were maintained for seven-day periods during the third and fifth weeks of the study; 72° was maintained during the remainder of the time. The study was supported by NASA.

Another phase of the experiment involved the subjects going without shaving, bathing, or brushing their teeth to determine minimum personal and oral hygiene requirements for long-term space flights.

Fresh foods were eaten at the four meals each day, but the menu was repeated daily.

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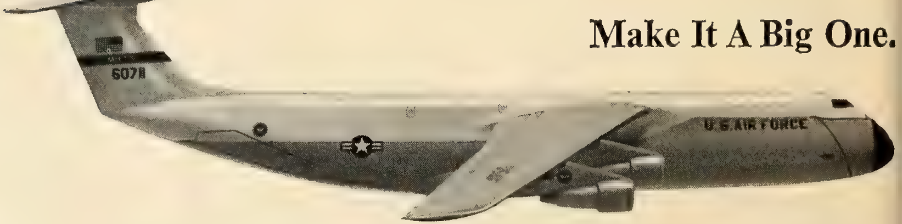

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Fatigue Facility at Wright-Patterson.

Five Air Force officers, including one woman, were subjects in the tests. Most tests lasted for two minutes, during which the subjects reported on subjective sensations and performed a number of other tasks. In the visual acuity area, their ability to read print and instrument dials was reported. In addition, they performed "E"-type eye tests to assess visual acuity at a distance of six feet.

Spatial orientation studies consisted of measurement of the subject's ability to perform a one-leg stand and to touch his nose with his index finger, and an objective target-dotting test in which the subject traces a circle, then tries, with his eyes closed, to dot the bull's eye from a raised-hand position.

Fine finger dexterity was measured through subject's ability to write, and through a circle-tracing test which indicated steadiness and coordination.

The subject's speech intelligibility was assessed through conversational ability, and through a Rhyme test scored by trained listeners.

Stress response measurements were made through subjective reporting of pain, vibration, respiratory changes, pressure build-ups in body cavities, vertigo, flushing, tingling, nausea, anxiety, fatigue and other feelings. Measurements of EKG and pulse rates were made in most cases.

● **Results**—The first test, conducted in the AMRL High-Intensity Noise Facility, was a simulation of the noise environment estimated for the crew compartment of a *Saturn*-boosted vehicle. There were no problems, and the only effects were minor chest-wall and body-hair vibrations. It was concluded that the exposure was unquestionably tolerable.

Another test, an exposure to the F-102 (J-57 with afterburner) engine, simulated the spectrum estimated within a *Saturn*-boosted crew compartment during max q. In this instance, with ear protection, the subjects also reported that the experience was tolerable, although there was mild chest vibration and complete loss of direct verbal communication.

The subjects entered the 6 x 9-ft. Thermal Structures Tunnel at Langley, in which a large volume of pressurized, heated air is caused to flow at high velocity through a throat into a large cylindrical diffuser tube producing a broad-band noise environment, including fields from 2.5 up to 10,000 cps. Exposures ranged from around 100 to over 140 db. These were also reported tolerable for short durations, although some interference with respiration, throat pressure and the like was noted.

In the Low-Frequency Noise Facility at Langley, a battery of tests were conducted through six narrow-band noise environments. The maximum-intensity low sonic exposures, around 25 cps and above, caused some gagging, visual field vibration and speech modulation. These effects were found to be unpleasant but not intolerable. In the infrasonic range, there was discomfort in the middle ear, but ear plugs alleviated the situation.

Other exposures to 24-discrete-frequency noise showed the same kind of objective and subjective responses as in the narrow-band spectra in the previous tests. While all exposures were judged tolerable, the scientists said, subjective sensations rose rapidly above 145 db.

In the last group of exposures, conducted at the Low-Frequency Siren facility, in the ranges from 40 upward to 100 cps, exposures were stopped because of "alarming" subjective responses. Voluntary tolerance was reached at 50 cps (153 db), 60 cps (154 db), 73 cps (150 db) and 100 cps (153 db).

Symptoms included headaches at 50 and 73 cps, coughing, severe substernal pressure, choking respiration, salivation, pain on swallowing, gagging and giddiness, flushing, and tingling at 100 cps. Significant visual acuity decrements also occurred in all subjects during the 43, 50, and 73 cps exposures, the scientists reported.

Subjective effects were varied among the subjects during the test, and no conclusions could be drawn about possible group and individual variability.

The AMRL group will conduct further tests with a new facility, the Dynamic Pressure Chamber, built at Wright-Patterson AFB. ■

Sealab Aquanauts Make 300-ft. Dive

Sealab II aquanauts showed no ill effects last week one day after descending to a depth of 300 ft. in Scripps Canyon off the coast of La Jolla, Calif.

The 19-min. dive of Robert Sheats and Bill Bunton took them deeper than any other aquanaut has gone. Sheats is leader of the final 15-day segment of the 45-day underwater experiment, which is to end Oct. 11.

Sheats and Bunton took photographs of what they called a virtual sea desert during the dive. The entire 10-man team (team 3) spent a total of 706 minutes outside their 57-ft. steel cylinder Oct. 5. The cylinder rests on a cliff 205 ft. below the surface.

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And: Electrical Design; Structures Design; Power Plant—Thermo-Mechanical; Flight Test Instrumentation; Flight Test Data Analysis; Reliability; Advanced Systems Engineering. Openings include a number of senior positions.

Libby Calls for Nuclear Space Ship Development

Multibillion-dollar project proposed at ISA meeting; Pickering cites need for adaptivity in instrumentation

by Rex Pay

LOS ANGELES—One of its preeminent nuclear scientists says the United States should give urgent attention to the development of a multibillion-dollar atomic-powered space ship capable of traveling to Mars and back in four weeks.

Dr. Willard F. Libby, director of the Institute of Geophysics and Planetary Physics and professor of chemistry at the University of California at Los Angeles, advanced a proposal for serious study of the project in his keynote speech to the 20th Annual Instrument Society of America Conference and Exhibit. The four-day meeting was held here Oct. 4-7.

"It would give us a very worthwhile post-*Apollo* program suited to our economy, capabilities and interests," Libby declared. He observed that while atomic energy is vital to the nation's post-*Apollo* space effort, much of the knowledge gained outside the space program itself has so far been neglected in space planning.

He specifically recommended consideration of a reactor complex capable of supplying 10,000 megawatts of power to an engine with a designed thrust of 15-20,000 lbs. He conceded that a space ship with such a powerplant would cost billions of dollars and be a decade in the building, but he said it would open the door to the solar system.

The space ship would require the ability to accelerate to 200 km/sec., Libby said, which, for minimum energy expenditure, would demand an exhaust velocity of 800 km/sec. This cannot be achieved with chemical engines or with the thermally heated atomic engines of the Rover and Phoebus type.

Ion engines have been proven to have some prospect of yielding such performance, he said, but their beams would have to operate at much higher energies. He envisioned a type of linear system in which ion and electron beams would be accelerated to the million-volt range and mixed to provide a neutral plasma from the ship's nozzle.

The reactor would require a 1,000-kg core of Uranium 225 weighing some 10 tons and costing $50 million. Cooling and electrical conversion machinery might weigh up to 20 tons. Libby said the SNAP 50 reactor might serve the purpose, but he recommended investigation of thermionic conversion and magnetohydrodynamics.

- **Space assembly**—It would be necessary to assemble the reactor in space. Main reactor plant could conceivably operate at the end of a mile-long cable—a separation that would be equivalent to 20 tons or more of shielding—although cable weight would have to be taken into account.

Libby said there might be an alternative in Project Orion, the currently shelved program to use atomic explosions to propel massive space platforms. He noted, however, that Orion planning probably would have to be revamped after initial tests determining the effects of sharp atomic explosions on steel plates. The shock of the explosions poses difficulties for manned spaceflight, he said, but the system might be very useful for delivering freight to the Moon.

Within its limitations, Rover-Phoebus development is proceeding very well, he reported, and appears certain to be highly successful in producing specific impulses two or three times greater than the best obtainable with chemical fuels. Hence, the system could be employed to run a ferry service to a Moon base.

- **Instrument adaptivity stressed**—Adaptive instrumentation is an important requirement for future unmanned interplanetary missions, Dr. William H. Pickering, director of Jet Propulsion Laboratory, told the opening meeting of a three-day Aerospace Instrumentation Symposium held in conjunction with the ISA conference.

Pickering said the member of the *Saturn* vehicle family to be used for the 1971 *Voyager* shot had not yet been selected. However, if *Saturn V* is used, its full capability of sending 25 tons to Mars will not be exploited.

He said specifications for the *Voyager* capsule continued to be delayed because of uncertainty as to the Martian atmospheric pressure. Current estimates vary between 5 and 10 millibars, he noted (M/R, Oct. 4, p. 14).

In view of the increasing number of instruments that can be carried on the larger interplanetary spacecraft now being studied, much more effort must be concentrated on the on-board data-handling and command system, said Pickering.

This might transmit data only when meaningful changes were recorded by sensors. Also, the data system should monitor the performance of instruments and, if a failure occurs, should take corrective action, perhaps switching in a redundant circuit. This can be done from the ground, said Pickering, but the time delays involved in such a method can create problems, particularly if failure occurs at a critical period during planetary encounter.

The central data unit should be able to adjust instrument ranges, changing the calibration when required. Also, it should be able to identify the occurrence of events and switch instruments on to monitor them.

For example, said Pickering, when a solar flare occurs, the ionization instrumentation calibration ranges should be changed and a photometer should be turned on to observe the Sun's surface. Furthermore, if the data rate coming into the spacecraft during such an event is too high, the data system should be able to record the data and retransmit them at a later time.

● **STARS II advances**—Data quantities being transmitted by unmanned Earth satellites are calling for new online processing techniques on the ground, Edmund J. Habib told the symposium. The 14 satellites for which NASA's Goddard Space Flight Center has mission responsibility put out an average of 60 million data points a day. This is expected to rise to 200 million data points in 1966.

Habib, associate chief of Goddard's Information Processing Div., said that the start-up of the STARS II system (Satellite Telemetry Automatic Reduction System) in 1966 would speed up the data-processing task. The new system will have two major advantages over the present STARS I. It will carry out signal-processing and quality-checking in a single integrated system—turnaround time between these two processes in the past has been too long—and the system will be fully automatic, with computer-controlled start-up and operation.

STARS II combines a Control Data Corp. 3200 general-purpose computer with special signal-processing equipment. Two subsystems will process PCM data; another will process PFM.

Normal data input will be from an analog tape recorded at a tracking station. Data from a real-time link can also be accepted, and a stored program simulator provides a third data source.

When recorded tape is used, it can be played into the systems at up to 32 times record speed. An input control unit provides automatic selection of the data sources, as well as speed and track selection for the analog tape playback units.

The two PCM subsystems include two signal conditioners, two group synchronizers, one stored-program controller and one limit-checking unit. The aim is to process two telemetry channels from a single satellite simultaneously, for example, two *OAO* data links received on separate carriers.

For overall system control, an executive routine in the CDC 3200 computer will provide full system set-up, including loading of the PCM and simulator stored-program controllers. The executive routine will also control job sequencing, accounting and calculation of statistics concerning system performance.

Once the cleaned-up tapes have been prepared, they are shipped to the experimenters. Their data processing, says Habib, averages about 488 instructions per data point. For the 200 million data points per day expected in 1966, this represents a weekly workload of 20 forty-hour shifts on IBM 7090 computers, not including set-up time, reprocessing or debugging.

● **Analysis speed-up**—This data workload has led to a long-range objective at Goddard of developing an efficient and centralized data-analysis facility.

Advanced Inflatable Antenna Shown at Raytheon

INFLATABLE ANTENNA designed for use in such systems as Apollo Applications program is examined at Raytheon Co.'s Space and Information Systems Div. Carried aloft in collapsed form only 2 ft. in size, it is inflated to 8-ft. inside and 10-ft. outside diameter. Weight of model shown is less than 8 lbs.

Habib said the first step in this direction is a plan at Goddard to acquire a high-volume, on-line data-storage and retrieval system. Aim is to be able to access any of the data equivalent to that on 10,000 reels of digital tape in a matter of seconds. Goddard is also planning to acquire high-speed mass memories for on-line use, storing up to one million data points.

Typical of the data reduction to be attempted is the generation of world maps of incoming and outgoing radiation. This was carried out for July-August, 1963, by the Goddard Institute for Space Studies, using *Tiros VII* data. The two maps represent the analyzed results of 200 million data points, obtained over three months.

On-line mass storage devices will speed up such information-processing tasks. Also, on-line color plotting equipment is expected to improve presentation. Ultimately, such maps may be produced in motion picture form, when continual coverage of this energy flow becomes feasible by means of satellites.

A more advanced step in data accessibility, said Habib, will be on-line display and communication for the scientific experimenters. Each experimenter would be supplied with an inquiry and display console and would have random access to a large amount of data with very short access time.

- **Monitoring parotid**—An automated system to monitor critical biological parameters in astronauts during extended space flights has been proposed to NASA by Beckman Instruments, Inc.

As urea, nitrogen and calcium concentrations appear to be critical from a biomedical standpoint, Beckman has proposed monitoring the concentrations of these in the fluid secreted by the parotid gland. This fluid enters the mouth through an opening in the cheek opposite the upper second molar.

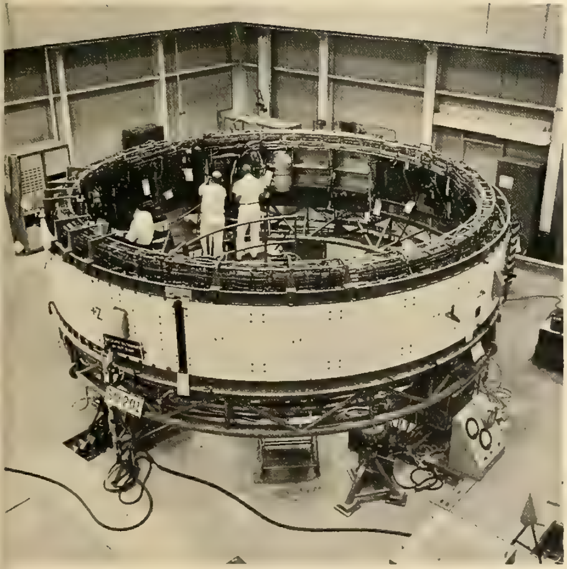
Outlining the proposal at the ISA meeting, a team of engineers from Beckman said advantages over blood or urine tests are ease of collection and a capability of reflecting body metabolism in real time. It is hoped that the technique will enable the prediction of an astronaut's capabilities.

Much more work is needed before the prognostic value of parotid samples is defined. Several components of parotid fluid have been found that distinguished between a random healthy group, a hospitalized group and a group of U.S. Marine pilots.

Samples would be collected by an elastomeric cup with special sealing ridges. The astronaut would attach it to the upper second molar by means of a tailored spring-wire clip. The sample is transported from the cup into a collection reservoir through a plastic tube, by the natural flow from the gland.

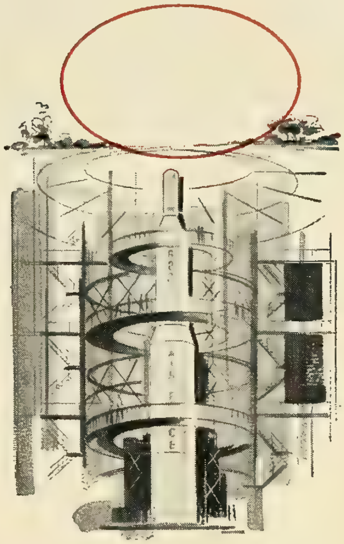
The collection reservoir would consist of a glass- or plastic-enclosed collapsed bladder, which would be inserted into an analyzer. The complete unit, including malfunction warning indicators and other displays, is expected to be within the 2-cu.-ft. volume and 80-lb. weight limitation for in-flight experiments in the Command Module of *Apollo* flights 4 and 5. ■

Saturn IB Instrument Unit Readied for Delivery



HUGE Instrument Unit destined for NASA's first Saturn IB booster shown near completion of testing at International Business Machines' Space Guidance Center in Huntsville, Ala. Unit is to be delivered to Cape Kennedy shortly for positioning on Douglas S-IVB second stage of launch vehicle, due for launching late this year or early in 1966. IBM has $175-million contract to produce and test 27 such units—12 for Saturn IB's, 15 for Saturn V's.

UNDERGROUND CORROSION PROBLEMS?



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HUNTSVILLE
WFIX (1450 KC) 7:15-7:20 AM
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Re-entry Considerations Prompt Apollo Changes

by Willard E. Wilks

BEVERLY HILLS, CALIF.—A number of *Apollo* design modifications have been made as a result of re-entry considerations, W. T. Armstrong, chief research pilot for North American Aviation's Space & Information Systems Div. reported at the Society of Experimental Test Pilots' symposium.

Investigations are still in progress, he reported, and it appears some significant changes in the crew procedure may result.

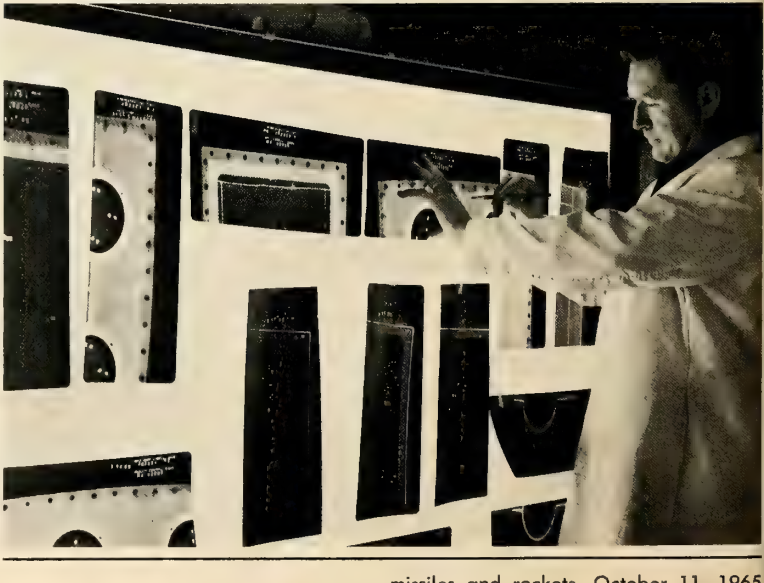
"Although the *Apollo* includes provisions for an automatically-controlled entry, it should be emphasized that this flight maneuver is accomplished in a rather severe environment and at the end of a long mission," Armstrong said at the recent meeting. "Accordingly, a major portion of our flight simulation effort has concentrated on failure analysis and manual control requirements." Design modifications have already resulted, although the investigations are still in progress.

- **Pilot performs well**—Armstrong reported that from a pilot's point of view, the most significant entry simulation results have evolved from experience with manual control. "In every case, where we have taken the pilot out of a monitoring role and have required him to fly the vehicle manually, overall mission performance has improved."

This has been most apparent in two areas, he said—time-critical systems failures are more easily detected and require less corrective response time if the pilot is actively participating in vehicle control at the time the failure

X-Raying Apollo Heat Shield

ENGINEER at Avco/RAD checks X-ray plates of Apollo Command Module ablative heat shield for voids, broken or crushed honeycomb cells and high-density inclusions that must be corrected before the shield passes Avco's quality control program.



occurs, and manual maneuvering in response to steering signals results in significant fuel savings with no sacrifice to terminal landing accuracy.

He also reported that major simulation studies have shown that the present free-flight mode concept for *Apollo* spacecraft docking is a relatively simple pilot control task that can be carried out without a fully functioning spacecraft and with considerable systems degradation as well.

The concept was adopted after investigation of other schemes, including one incorporating a steel cable attachment that "showed great promise of becoming the world's most expensive yo-yo."

Armstrong said simulations showed the present method could accomplish docking within accuracy limits on a vehicle that is tumbling about all axes, even if the *Apollo* pilot should lose attitude hold, automatic rate damping and a reaction control quad.

- **Simulation tools needed**—In another portion of the symposium, NASA research pilot Milton O. Thompson reported that omission in duplication of the flight environment in the simulator almost caused loss of an *X-15* research aircraft. Thompson cited piloting problems encountered in the *X-15* caused by simulation deficiencies or simulation limitations imposed by omission of complex and costly flight environment conditions.

On the occasion in which the aircraft was almost lost, a severe vibration at 13 cps was experienced in the *X-15*. Investigation indicated that at low dynamic pressure in the absence of aerodynamic damping, the structurally lightly damped horizontal-tail surfaces were excited at their natural frequency by pilot control inputs. The inertial reaction to this oscillation was sensed by the stability-augmentation-system gyros, which closed the loop through the control system. The problem could have been predicted on the simulator if sufficient consideration had been given to its occurrence, Thompson said.

He also reported these *X-15* piloting problems due to lack of simulation:

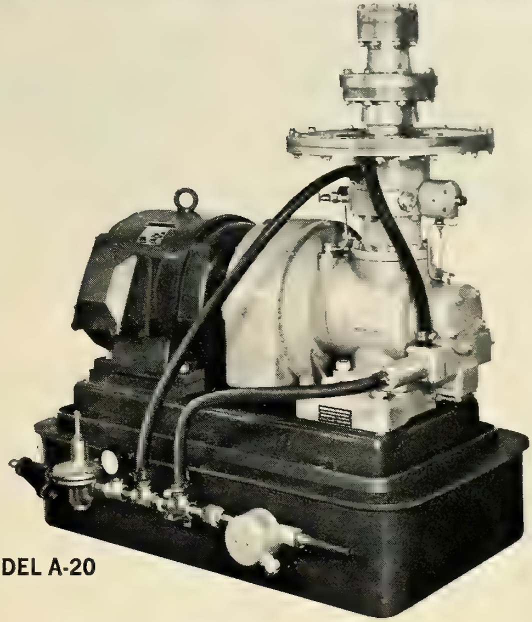
—Horizon is lost at a pitch angle of about 10 degrees because of head position and window size. As a result, the pilot "swears he is going straight up and on a number of occasions has pushed over to look for the horizon," resulting in low peak altitudes.

—Main-gear landing loads were much higher than anticipated because of a natural pilot control response. These also might have been indicated by realistic landing simulations.

—Discrepancies in cockpit duplication in the simulator, including an instrument in one case, resulted in flights being off the desired flight plan. ■

NEW

ULTRA-LOW CRYOGENIC REFRIGERATION CAPACITY

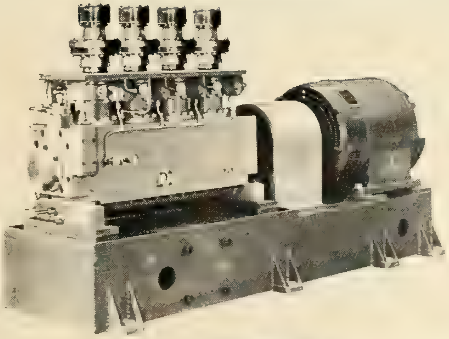


MODEL A-20

The Model A-20 Cryogenerator, utilizing the proven Stirling cycle principle, is capable of furnishing refrigeration at temperatures ranging from ambient down to 12°K. Its useful operating range extends from 80°K to 12°K. The thermodynamic design permits simultaneous extraction of refrigeration at two levels—50°K to 80°K at the *intermediate* freezer, and 40°K to 12°K at the *cold* freezer.

This unusual versatility makes the A-20 suitable for many ultra-low temperature applications including cold-spot cooling of IR systems, masers, lasers and other electronic devices; superconduction, cryo-pumping, and hydrogen or neon liquefaction/recondensation. Coupled with an external helium JT loop, the A-20 provides a compact, reliable helium liquefier or a 12°K-4°K dense gas refrigerator system.

In addition, the A-20 can be furnished with an optional basic flange provided with feed-throughs suitable for mounting an insulating enclosure.



MODEL B-20

The B-20 Cryogenerator, like its counterpart the A-20, has been similarly designed with *cold* and *intermediate* take-offs. However, refrigeration capacity is four times that of the A-20 Model.

Norelco® CRYOGENIC DIVISION

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E-65

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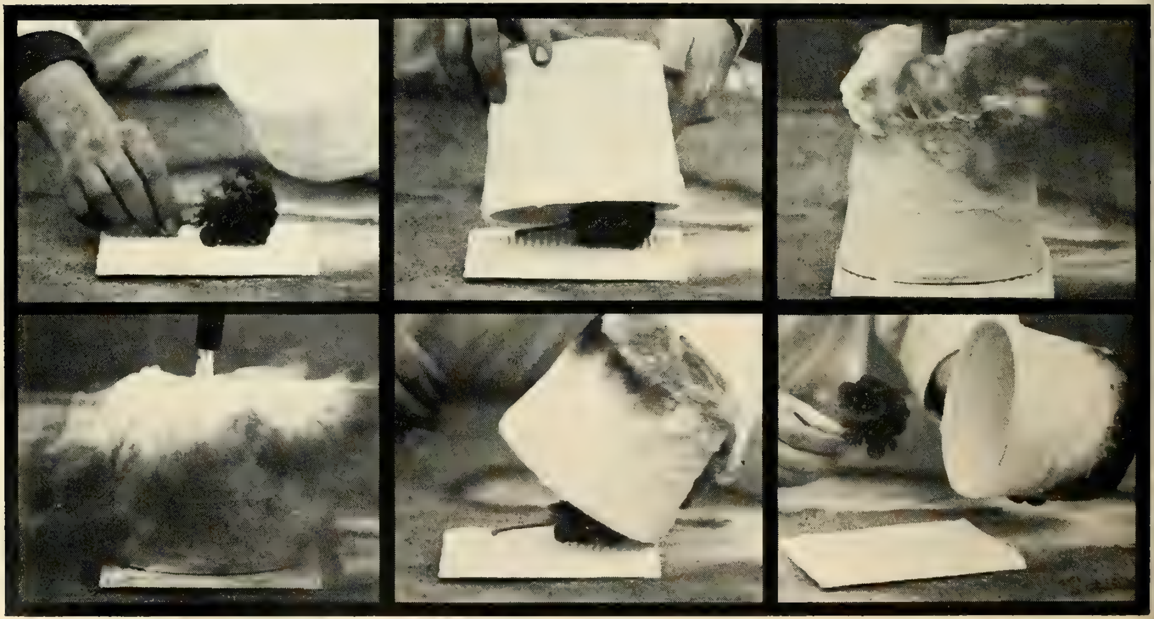


New flameproof RTV-757 Silicone Rubber withstands 5000°F for 60 seconds...and the flower doesn't even wilt!

Paint a thin layer of G-E RTV-757 on a paperboard carton. Subject it to a 5000°F flame for one minute. RTV-757 will not only prevent the paperboard from burning, but keep it cool inside (inside temperature will rise from 71°F to a modest 84°F).

RTV-757 can provide the same protection to the equipment you build, whether it be a cabin compartment, a fuel storage tank, an insulating garment or a protective shield.

What is RTV-757?

It is a thixotropic paste which can be foamed over a surface to form a tough, lightweight shield of silicone rubber which provides unusual protection from heat and combustion. It cures from a tacky paste to a rugged foam in minutes after heat is applied, forming a thermal insulating blanket that also provides low temperature flexibility (below —150°F). It bonds to almost any primed surface, and can be easily applied to any surface.

Whether used as a firewall blanket, an ablative heat shield, a potting and encapsulating compound, or to protect compartments in aircraft, tanks, ships or stationary equipment, new RTV-757 offers a degree of flame resistance previously impossible in silicone rubbers. For information, write to Section 010158, Silicone Products Department, General Electric Company, Waterford, New York.

GENERAL ELECTRIC

Circle No. 9 on Subscriber Service Card

Mergers and Acquisitions

Control Data Corp., Chicago, has agreed to acquire Howard Research Corp., Arlington, Va., electronic systems development firm for an undisclosed amount of Control Data stock. Control Data's aim in the proposed acquisition is to expand its capabilities in electronic, military and weapons systems programs. . . . *Components, Inc., Biddeford, Me., has purchased the SEMCOR Solid State Div. of the Nuclear Corp. of America, Phoenix, Ariz. SEMCOR makes zener diodes, temperature-compensating reference elements and hermetically sealed tantalum capacitors. Components, Inc., manufactures subminiature solid tantalum capacitors and a second line of commercial solid tantalum capacitors.* . . . David Industries, Santa Ana, Calif., has purchased Evaporation Apparatus, Inc., San Marino, Calif., a specialist in the manufacture of vacuum equipment. David Industries is a management and holding firm. . . . *Consolidated Controls Corp., a subsidiary of Condec Corp., Stamford, Calif., has acquired the assets and business of Carl Drescher Co., Inc., of Burbank, Calif. Drescher makes hydraulic and pneumatic components for jet aircraft.* . . . Walter Kidde & Co., Bellville, N.J., has agreed to acquire Park Products, Inc., Geneva, Ohio, a manufacturer of electromagnetic components for electronic and electrical equipment.

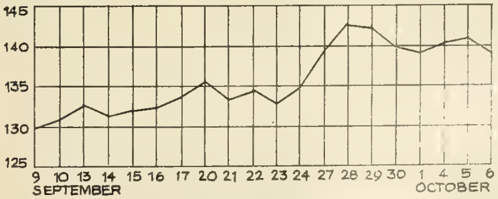
New Activities

Electronic Communications, Inc., St. Petersberg, Fla., has given division status to Standard Precision, Inc., of Wichita, Kans., a wholly owned subsidiary. To be known as the Standard Precision Div. of Electronic Communications, the operation will continue to produce instruments and electromechanical equipment for the general aviation market. Electronic Communications makes space, airborne, mobile and ground communications systems. . . . *D&L Consultants, a technical and management consulting firm has been formed in Wilkes Barre, Pa., by Thomas Dombroski and Carl Luksic. Dombroski was formerly a senior engineer with Sylvania Electric Products; Luksic, an associate engineer in systems equipment engineering with Western Electric Co., Inc.*

Facility Expansions

The Vector Div. of United Aircraft Corp., has broken ground on a multi-million-dollar facilities expansion that will add 185,000 sq. ft. to the division's present 64,000-sq.-ft. combined facilities in Bensalem Township, Pa. Vector designs and makes analog and digital telemetry systems for use in missiles, satellites, manned space vehicles, missile test range communication systems and aircraft. . . . *The Pennsylvania State University, University Park., Pa., has established a Space Sciences and Engineering Laboratory as a part of the Institute for Science and Engineering. Among the lab's function will be the collection of information on space research at the university. NASA provided $600,000 toward the cost of the laboratory.* . . . Datamec Co., a division of Hewlett-Packard Co., Palo Alto, Calif., has announced plans to construct a $1-million, 65,000-sq.-ft. plant at Mountain View, Calif. Approximately 400 persons are expected to be employed initially at the new plant, and a master plan calls for ultimately tripling the size on the 16-acre site acquired for the project. . . . *TRW Metals Div. has made public plans to begin construction immediately of a $1.25-million expansion on the division's Minerva, Ohio, plant. Work will include 45,500 sq. ft. of manufacturing and 20,100 sq. ft. of office space, plus the relocation and refurbishment of equipment and facilities in almost every department. The Metals Div. makes investment castings and vacuum cast superalloys for components and assemblies for aerospace, underwater weapons systems, nuclear aircraft and commercial applications.* . . . Angstrohm Precision, Inc., North Hollywood, Calif., has begun construction of a 24,000-sq.-ft. facility to house its Key and Angstrohm divisions effective Nov. 1. Angstrohm-Key makes evaporated metal film resistors and networks for the high-reliability metal film market. . . . *Weston Instruments, Inc., Hatboro, Pa., has established a Waveform Analysis Center to provide spectrum signature data. Major capabilities are said to include low-cost investigation of transient and random signals in dynamic environments for determination of signal contact, power spectra and transfer functions.* . . . Clairex Corp., New York City manufacturer of photocells, has moved into additional quarters, doubling the size of its original 10,000-sq.-ft. operation. The new facility will be used for production and development of such new products as encapsulated photocells, large cell matrixes and Photomods, the company's new unitized photocell/light source device. . . . *Hi-Q Div. of the Aerovox Corp., has added 30,000 sq. ft. to the company's Myrtle Beach, S.C., ceramics manufacturing, chemical engineering laboratories, office and production areas. Estimated cost of the new construction is $300,000. The new construction brings total facilities space at Myrtle Beach to 110,000 sq. ft.*

Missile/Space Stock Index



100 = CLOSING PRICES OF 19 REPRESENTATIVE AEROSPACE FIRMS DEC 31, 1964
STOCK PRICES FURNISHED BY MERRILL LYNCH, PIERCE, FENNER AND SMITH

contracts

AIR FORCE

$5,076,600—**Sylvania Electric Products, Inc.**, New York City, for continued work on an antenna subsystem for *Minuteman* missiles in Buffalo, N.Y., and Waltham and Needham, Mass.

$4,073,000—**Atlantic Research Corp.**, Alexandria, Va., for continued development of special test vehicles for a space re-entry program.

$3,406,330—**Goodyear Tire & Rubber Co.**, Litchfield Park, Ariz., for production of radar mapping equipment.

$2,659,000—**American Air Filter Co.**, Defense Products Group, Louisville, Ky., for environmental control equipment for *Minuteman* missile installations.

$1,562,000—**Thiokol Chemical Corp.**, Huntsville, Ala., for work on solid-fuel rockets.

$1,303,180—**International Business Machines Corp.**, Poughkeepsie, N.Y., to manufacture components for electronic data-processing equipment.

$1,200,000—**Martin Co.**, Friendship International Airport, Md., to continue analytical studies and experiments in connection with air-augmented rocket vehicles.

$1,175,000—**Burroughs Corp.**, Radnor, Pa., increment for maintenance and supply support for a radar course directing system.

$430,806—**General Electric Co.**, Missile and Space Div., Philadelphia, for rocket motors ignitors for re-entry system on *Titan II* and related data.

$391,000—**Radio Corp. of America**, Missile & Surface Radar Div., Moorestown, N.J., increase in contracts for electronic equipment.

$188,000—**Cornell Aeronautical Lab., Inc.**, Buffalo, N.Y., for the election and identification of targets.

$165,000—**Radio Corp. of America**, Aerospace Systems Div., Burlington, Mass., increase in contract for a variable instruction computer.

$121,505—**Union Carbide Corp.**, Linde Div., New York, N.Y., for propellant pressurizing agent.

$95,000—**General Dynamics/Convair**, San Diego, Calif., for research and experimental studies in support of satellite meteorology.

Stromberg-Carlson Corp., San Diego, Calif., for the study of a new random access light valve technique, to be used in large screen displays (amount not disclosed).

Westinghouse Electric Corp., Semiconductor Div., Youngwood, Pa., for optimization of a 1x30-cm. silicon web solar cell, and the delivery of a quantity of cells for fabrication of solar panels (amount not disclosed).

ARMY

$17,429,937—**Martin Marietta Corp.**, Orlando, Fla., for continued work on the *Pershing* missile system.

$4,367,640—**Western Electric Co.**, New York, N.Y., for continued development work on the *Nike* antimissile program.

$4,094,804—**Sperry Rand Corp.**, Sperry Utah Co. Div., Salt Lake City, Utah, for *Sergeant* missile product and production engineering services.

$4,000,000—**Atlas Chemical Industries**, Wilmington, Del., to reactivate and operate portions of Volunteer Army Ammunition Plant.

$3,863,247—**Ling-Temco-Vought, Inc.**, Dallas, for technical support of the *Nike-X* program on Kwajalein Island in the South Pacific.

$3,500,000—**Union Carbide Corp.**, New York City, to supply a total of 933,140 batteries for electronics communications equipment.

$2,317,910—**Martin Marietta Corp.**, Orlando, Fla., for modification work on the *Pershing* missile system.

$2,198,500—**General Dynamics Corp.**, Convair Div., Merritt Island, Fla., for designing, furnishing and installing an operational TV system for Launch Complex 39.

$2,034,960—**General Precision, Inc.**, Clifton, N.J., for work on *Pershing* missiles.

$2,000,000—**Philco Corp.**, Newport Beach, Calif., to make test equipment for the *Shillelagh* antitank missile.

$1,925,000—**Allis-Chalmers Manufacturing Co.**, Milwaukee, Wis., for the production and delivery of 65,200 kilowatt diesel-engine-driven generator sets.

$1,852,268—**Bendix Corp.**, Teterboro, N.J., for work on the guidance and control system for *Pershing* missiles.

$1,602,119—**Stanford Research Institute**, Menlo Park, Calif., for studies for the anti-missile missile system.

$1,367,338—**Eisen Bros., Inc.**, Lodi, N.J., for manufacture of projectile parts.

$1,238,214—**Western Electric Co.**, New York, N.Y., for continued work on the *Nike-Hercules* air-defense missile.

$1,119,100—**Benton Corp.**, Troy, Mich., for modification kits for the transporter of *Hawk* missile loaders.

$1,005,957—**Eastern Tool & Manufacturing Co.**, Belleville, N.J., for projectile parts.

$645,794—**Raymond Engineering Lab., Inc.**, Middletown, Conn., for S and A devices.

$330,000—**Raytheon Co.**, Andover, Mass., for *Hawk* missile system repair parts.

NAVY

$2,055,208—**General Dynamics Corp.**, Pomona, Calif., option to existing contract for retrofit changes for *Terrier* and *Tartar* missiles.

$1,303,672—**Lockheed Missiles and Space Co.**, Sunnyvale, Calif., for *Polaris* surface support equipment.

$199,021—**Aircraft Armaments, Inc.**, Pacific Div., Northridge, Calif., for design, test, development of model multi-beam passive sonar analyzer and display equipment.

$89,350—**Philco Corp.**, Aeronutronic Div., Newport Beach, Calif., for study program on optimum fuzing techniques.

$71,350—**Honeywell, Inc.**, Military Products Group, Minneapolis, Minn., for ring laser rate sensing gyroscope system.

NASA

$3,832,194—**Lockheed Aircraft Corp.**, Lockheed Electronics Co. Div., Houston, from MSC for general electronics, instrumentation and engineering support.

$1,350,411—**Texas Instrument Inc.**, Dallas, from Goddard Space Flight Center for infrared interferometer spectrometer.

$572,600—**International Telephone and Telegraph Corp.**, Fort Wayne, Ind., from Goddard Space Flight Center for continuous scanning for meteorological camera system experiment for *Applications Technology Satellite*.

$518,262—**Radio Corp. of America**, Astro Electronics Div., Princeton, N.J., for *Applications Technology Satellite* ground support equipment. Also $1,324,270 for *Nimbus B* solar conversion power supply.

$393,821—**Citro Electronics**, Silver Spring, Md., from Goddard Space Flight Center for *Apollo* VHF telemetry receiving systems.

$331,429—**Sperry Rand Corp.**, Univac Div., Washington, D.C., from Goddard Space Flight Center for programming services for communications processor.

$287,570—**Lockheed Missiles and Space Co.**, Sunnyvale, Calif., for pulse code modulated ground telemetry station stored program.

$240,877—**Hoffman Electronics Corp.**, El Monte, Calif., from Goddard Space Flight Center for solar cell panels.

$148,900—**Dudley Observatory**, Albany, N.Y., from Manned Spacecraft Center for micrometeorite collection device and experiment.

$44,740—**Hughes Research Laboratory**, Malibu, Calif., for an investigation of techniques of image processing and pattern recognition and the design of an image recognition system.

$43,577—**Trylon, Inc.**, Elverson, Pa., for dual nested transmit rhombic antenna.

$38,000—**Measurement Analysis Corp.**, Los Angeles, from Marshall Space Flight Center for study of maximum capabilities of present day force measuring devices.

$32,238—**Hoffman Electronic Corp.**, Santa Barbara, Calif., for modified spectro-photometer calibrator.

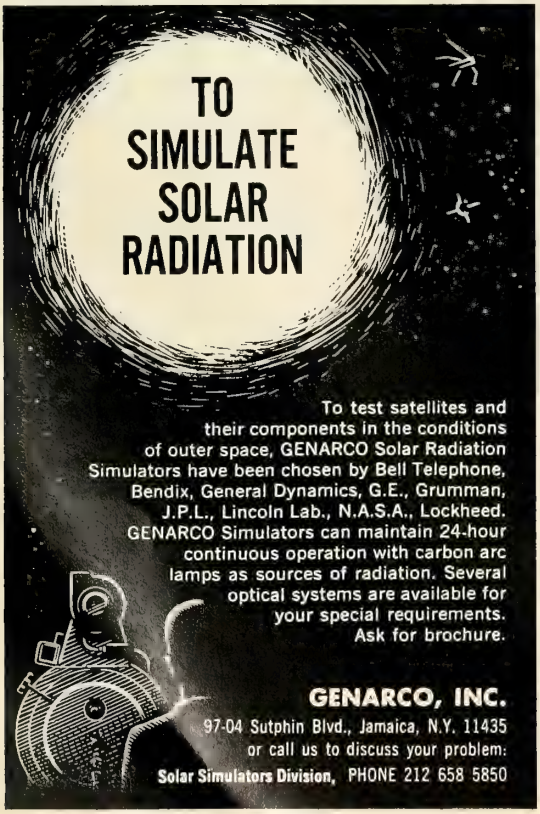
INDUSTRY

$1,565,000—**Radio Corp. of America**, Communications Systems Div., Camden, N.J., increase in contract from **Boeing Co.**, Seattle, for the *Minuteman* program.

$1,370,393—**Cornell Aeronautical Laboratory**, Buffalo, N.Y., from **Bell Telephone Labs.**, New York, N.Y., for continued research on the radar signature characteristics of potential *Nike-X* targets.

$363,000—**Raymond Engineering Lab., Inc.**, Middletown, Conn., from **Avco Corp.**, Richmond, Ind., for fabrication of *Polaris* missile components.

$312,000—**Dorsett Electronics, Inc.**, Tulsa, Okla., by **Ryan Aeronautical Corp.**, San Diego, Calif., for complete telemetry systems for the *Advanced Firebee* drone.



To test satellites and their components in the conditions of outer space, GENARCO Solar Radiation Simulators have been chosen by Bell Telephone, Bendix, General Dynamics, G.E., Grumman, J.P.L., Lincoln Lab., N.A.S.A., Lockheed. GENARCO Simulators can maintain 24-hour continuous operation with carbon arc lamps as sources of radiation. Several optical systems are available for your special requirements. Ask for brochure.

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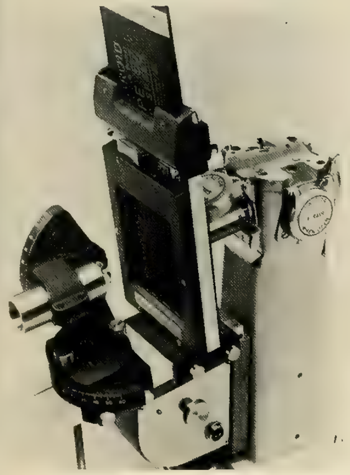
Circle No. 10 on Subscriber Service Card

New Product of the Week: X-Ray Crystal Analyzer



An apparatus for instant recording of X-ray diffraction patterns in crystallography is being marketed by Materials Research Corp.

The XR-7 system uses Polaroid Land photography for X-ray crystal analysis. Key to the system, the firm says, is the XR-7 Land Diffraction Cassette, which permits use of self-developing film packets with most standard X-ray diffraction units.

According to the distributor, the system provides an X-ray photograph seconds after shooting it. Exposures are reduced to as little as 1/50 the exposure needed with conventional X-ray film. No darkroom is required at any point in the system.

In operation, the diffraction cassette is mounted on the diffraction camera track and a film packet inserted. During exposure, the X-rays strike a lead-backed intensifying screen coated with phosphor. This fluoresces and converts the X-ray information into visible light which exposes the film. Photographs are processed in 10 seconds under normal light.

Two models of the cassette are available—#57-1 for Laue work and #57-2 for precision work.

Circle No. 151 on Subscriber Service Card

Oscillator Power Amp

Raytheon Co.'s Laser Advanced Development Center has developed a master oscillator power amplifier (MOPA) laser system with a 600-megawatt power output.

The LHP-1 system incorporates two water-cooled, single-elliptical-cavity laser heads; a dual-section power supply; a choice of three Q switches—a Pockels cell, a Cryptocyanine switch or a Kerr Cell.

In the MOPA configuration, the pulse repetition rate is one pulse every 30 seconds, delivering 6 joules in a 10-nanosec. pulse width. The oscillator will deliver 3 joules in a 10-nanosec. pulse width for an output of 300 megawatts. Output wavelength is 6,943 Angstroms.

Circle No. 152 on Subscriber Service Card

Portable Gas Detector

A portable detector for combustible gas mixtures has been developed by Barton Instrument Corp.

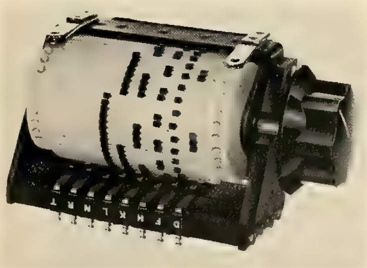
The Model 282 Gastron® will detect hydrocarbon concentrations from 50 ppm to 20% gas/air mixtures. The Model 310 will detect hydrogen concentration from 50 ppm to 5% gas/air mixtures.

The unit operates by drawing a continuous sample of air through a sensing element where controlled catalytic combustion occurs, causing a signal to be generated which feeds both a visual and an audio indicating circuit.

Circle No. 153 on Subscriber Service Card

Programming Switch

A 64-position ACTAN® programming switch has been introduced for binary coding applications by Sealectro Corp.



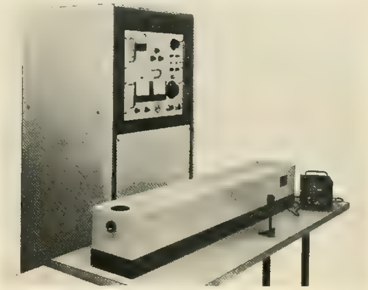
The device activates two banks of eight form C snap-action contacts simultaneously. The positions are detented, providing snap-action operation when the manual control dial is rotated. The unit is completely field adjustable for any program without tools and with 100% repeatability.

Circle No. 154 on Subscriber Service Card

Continuous-Wave Laser

A solid-state laser beam operating at a power level in excess of 40 watts has been announced by Union Carbide Corp.'s Linde Div.

The laser crystal is a neodymium-doped yttrium aluminum garnet with a low pumping threshold especially suited for CW applications. Laser output is at a wavelength of 1.06 microns.



The pumping source is a high-intensity radiation device. The arc system can provide radiation in forms of line source at any desired level of radiated power up to 50 kw.

Circle No. 155 on Subscriber Service Card

SPST Switch

Sanders Associates, Inc., is marketing a solid-state switch capable of handling up to 100 watts CW power—average or peak.

The Model DS-650 operates in a frequency range of 100 to 600 mc. Isolation at 100 mc is typically greater than 42 db; at 500 mc, it is greater than 31 db.

The unit will switch (10% to 90% points) at speeds up to 200 nanosecs. Insertion loss across the bandwidth is less than 0.5 db. VSWR is typically below 1.7; impedance is 50 ohms nominal.

Circle No. 156 on Subscriber Service Card

Alignment/Inspection Unit

Westinghouse Electric Corp. is marketing a mechanical alignment and inspection machine designed specifically for the semiconductor integrated circuit industry.

The Model 702 microscope has a vertical illuminator, X-Y motion and coarse and fine adjustments. The optics comprise a binocular metallurgical microscope with a revolving-turret triple objective which scans a 2×2-in. mask. Eyepieces and objective lenses, from 7.5× to 15× and from 4× to 20×, permit magnifications up to 600×. Electrical requirements are 120v ±1%, 60 cycle, single phase, 650 watts.

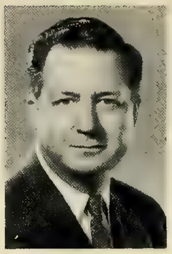
Circle No. 157 on Subscriber Service Card

names in the news

GERHART

KNIGHT

MANSON


CHANDLER

Gen. John K. Gerhart (USAF-Ret.): Appointed assistant to the president of Lear Siegler, Santa Monica, Calif. His main responsibility will be in long-range planning of new product development.

Dr. John Knight: Named as senior physicist at Operations Research, Inc., Silver Spring, Md. He was former assistant to the chief scientist of the British Royal Navy.

Brig. Gen. Hugh B. Manson: Appointed commander of the Systems Engineering Group at Wright-Patterson Air Force Base, Ohio. Gen. Manson is now vice commander of Aeronautical Systems Div. at Wright-Patterson.

R. D. Chandler, Jr.: Named general manager of the Houston Aerospace Systems Div., Lockheed Electronics Co., Plainfield, N.J.

Four executive appointments have been announced as part of a reorganization of the Florida Aeronautical division of Honeywell Inc. **Lee E. Sheehan** was named manager of engineering and program operations; **A. W. Kelley** is now manager of production and procurement; **W. M. Davis** is director of the new tactical systems department; and **Robert O. Maze** is director of central engineering.

Jack Marcinek: Appointed technical director for the systems management and engineering department of Fairchild Space and Defense Systems.

Philip B. Crosby: Appointed director of quality control for International Telephone and Telegraph Corp.

F. L. Bernstein: Recently joined Planning Research Corp. as manager of Undersea Warfare in the Systems Engineering Div. He will also head the company's work on anti-submarine warfare effectiveness for the Ocean Systems and Simulation Dept. in Washington, D.C.

Ronald A. Cohen: Joined the scientific staff of the Sperry Rand Research Center. He will specialize in research in metal oxide semiconductor integrated circuits.

Dr. John E. Meggit: Appointed manager of the advanced design section of Electronic Associates, Inc., also appointed as manager of system programming section was **Glenn L. Holtkamp.** Both appointments are in the newly created Advanced Development Dept. at EAI's Research and Computation Div.

Samuel M. Berkowitz: Appointed to the newly created post of manager, product planning, Communications Systems Div. of Radio Corp. of America. He was formerly with Philco Corp.

Alec Harley Reeves: Awarded the Stuart Ballantine Medal of the Franklin Institute. He is the inventor of the pulse code modulator that was used by *Mariner IV* to transmit television pictures from Mars to Earth.

Donal B. Duncan: Appointed chairman of the 1966 National Conference of the American Astronautical Society. He is assistant general manager of the Aeronutronic Div. of Philco Corp. where he is responsible for line activities in the fields of tactical weapons, re-entry systems, space systems, reconnaissance and intelligence systems, and electromechanical products.

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—when and where

International Electrotechnical Commission, general meeting, Tokyo, Japan, Oct. 10-23.

International Conference on Safety Fuels, and Core Design in Large, Fast Power Reactors, Argonne, Ill., Oct. 11-13.

Fourth Manned Space Flight Meeting, sponsored by the AIAA, St. Louis, Oct. 11-13.

Annual Meeting of the Users of Automatic Information Display Equipment, Holiday Inn, New York City, Oct. 11-14.

Ninth Conference on Analytical Chemistry in Nuclear Technology, sponsored by Oak Ridge National Laboratory, Gatlinburg, Tenn., Oct. 12-14.

Advisory Group for Aeronautical Research and Development, Flight Mechanics Panel, Rome, Italy, Oct. 13-15.

International Congress and Exhibition for Instrumentation and Automation, sponsored by the Nordwestdeutsche Ausstellungs- und Messe-Gesellschaft mbH (NOWEA), Dusseldorf, Germany, Oct. 13-19.

Third Annual National Conference of Professional Engineers in Industry, sponsored by the PEI functional section of the National Society of Professional Engineers, Oklahoma-Sheraton Hotel, Oklahoma City, Oct. 15-16.

Southwestern Science Exposition, El Paso's Coliseum, El Paso, Tex., Oct. 13-17.

American Institute of Aeronautics and Astronautics/Canadian Aeronautics and Space Institute Joint Meeting, Mount Royal Hotel, Montreal, Canada, Oct. 18-19.

IEEE 12th Nuclear Science Symposium, organized by the IEEE Nuclear Science Group, San Francisco, Oct. 18-20.

International Conference on Dynamics Stability of Structures, cosponsors: Air Force Office of Scientific Research and Northwestern University, Northwestern University, Evanston, Ill., Oct. 18-20.

25th National Convention of the Society for Nondestructive Testing, Cobo Hall and Embassy Hotel, Detroit, Oct. 18-22.

Electronic Packaging Conference, sponsored by the Society of Automotive Engineers, Inc., International Hotel, Los Angeles, Oct. 20-21.

1965 International Electron Devices Meeting, sponsored by the Institute of Electrical and Electronics Engineers, Sheraton-Park Hotel, Washington, D.C., Oct. 20-22.

1965 Annual Meeting of the National Aeronautic Association, Mayflower Hotel, Washington, D.C., Oct. 21-23.

Photography in Information Storage and Retrieval, sponsored by the Society of Photographic Scientists and Engineers and the Army Research Office, Marriott Twin Bridges Motor Hotel, Washington, D.C., Oct. 21-23.

21st Anniversary National Electronics Conference and Exhibition, McCormick Place, Chicago, Oct. 25-27.

Third Annual Conference on Energy Conversion and Storage, sponsored by Oklahoma State University School of Electrical Engineering, Stillwater, Oct. 28-29.

Seminar on "Determination of Physical Properties of Materials Through Sonic Resonant Methods," sponsored by Magnaflux Corp., Battelle Memorial Institute, Columbus Laboratories, Columbus, Ohio, Nov. 3-4.

1965 Space Fair, sponsored by the Navy, Pacific Missile Range Headquarters, Point Mugu, Calif., Nov. 6-7.

1965 Winter Annual Meeting of The American Society of Mechanical Engineers, Chicago, Nov. 7-12.

Two-week Course on "Reinforced Plastics—Principles and Applications," sponsored by the University of California, Engineering Building, Westwood Campus, Nov. 8-19.

18th Annual Conference on Engineering in Medicine and Biology, co-sponsors: Instrument Society of America and IEEE, Sheraton Hotel, Philadelphia, Nov. 10-12.

Aircraft Design and Technology Meeting, International Hotel, Los Angeles, Nov. 15-18.

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The Magic Trees

JUST A FEW WEEKS AGO in San Francisco, a session of the American Astronautical Society was jolted by the declaration that space research is hampering the American economy to such an extent that it threatens the survival of the U.S. as a nation.

The speaker was President Beardsley Graham of Spindletop Research. He is not the first to express the views of this particular school of thought although it is unusual to hear them coming from someone who has been active in the space field. Perhaps because of this, he put the case rather well, and it is worth devoting some attention to what he had to say.

"For the past several years," declared Mr. Graham, "we have been wandering through the enchanted forest of Space Science, waiting expectantly for the magic trees to bring forth the fruit of good living. Why has Space Science, which promised so much, delivered so little? What can we do to realize the acknowledged potential of such R&D?"

Insofar as the national civilian economy is concerned, he said, the plain fact is that space research and development has neither answered the needs nor satisfied the wants.

"Science has been seduced by government dollars and the glamour of space," Mr. Graham charged. "Yet the goals of the space program are not scientific goals, they are political goals and military goals are political, too."

Advances in space and military technologies do not accelerate economic growth, he said, and are in fact "more likely to deter the advance of industrial technologies and reduce the rate of economic growth."

Mr. Graham cited some three-year-old figures from the *Harvard Business Review* as evidence that the pattern of R&D expenditure in the U.S. is reducing the economic growth rate.

"The reason is basic," he declared. "Economic growth results from R&D which is oriented toward such growth. It does not result from R&D directed toward space and military achievements."

Now, while Mr. Graham stands around waiting for the magic trees to drop some fruit on his head, let's take a look at the facts. The truth is that the advancement of technology, whether in government-funded defense and space programs or civilian-funded industrial programs, is of immense and direct benefit to the nation. It is, as Mr. Graham suggests, vital to survival. The struggle between nations is a battle of technologies, in all fields. But it matters little whether this new technology is developed by a firm working on a government contract or employing company funds in its own laboratory.

Technology cannot be sold in a bottle, but neither can it be bottled up. One need only look at microelectronics, or materials, to see how swiftly advancing technology can flow through the entire economy, from many sources.

Mr. Graham slights NASA's effort to encourage and demonstrate economic spill-over from space science through its Technology Utilization Program.

The major point he misses, however, is that the difficulty faced by NASA, or anyone else trying to trace the flow of technology, is not that there is no flow; there is, in fact, a flood; the problem lies in trying to trace that flood from its many sources to its many outlets.

The usual result is to fish out a pathetic little example of a commercial product which can be traced back to the space program. One outlined recently to a Congressional committee concerned a new alkali silicate paint now on the civilian market following its development at Goddard Space Flight Center for use as a spacecraft coating. But this, to us, is of interest because its commercial introduction is a direct result of participation by the paint products company in NASA's excellent program to acquaint industrial firms with developments of interest in the space program. As a by-product, this makes the transfer of technology easier to trace. But it is no less real when it cannot be traced, as in most cases.

THE FACT IS THAT one doesn't stand by the bank and exclaim, "Here comes a piece of NASA's advanced technology," thereupon fishing it out and putting it to use. Advanced technology flows like a riptide and is absorbed all through the nation's industrial economy, usually with little knowledge of the many springs which feed the flow.

The man who wants to be shown the examples truly is asking for a bucket of water without being aware that he is swimming in an ocean.

Nor is NASA the only source in government. The Air Force development program, for example, recently has come up with a composite material formed from boron fibers in a plastic base, demonstrated in the laboratory to have approximately five times the specific strength of today's aircraft alloys. This is a larger single gain than has been achieved in the last 3,000 years. As yet, it is only being used experimentally, but its potential for the entire economy is evident.

It is true, as Mr. Graham and others suggest, that there is a need for a continuing close scrutiny of the new technology to assure that we reap the maximum benefits.

But to state, as he does, that defense and space R&D expenditures not only are not a boost to the economy but are an actual burden reducing the rate of economic growth is to distort the picture.

Any substantial reduction of defense and space R&D funds, unless balanced by new R&D emphasis elsewhere, will slow down the rate at which we develop new technology. That is one reason the heavy-handed approach to R&D at the Dept. of Defense is of concern to so many thinking individuals. If such a reduction ever does happen, then our national survival will indeed be in jeopardy and Mr. Graham may well find that Spindletop, the enchanted forest, the magic trees and the fruit all have disappeared.

William J. Coughlin

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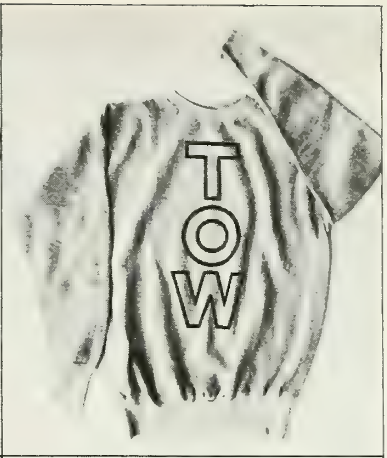

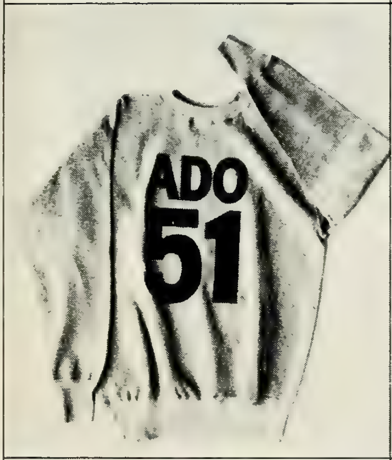

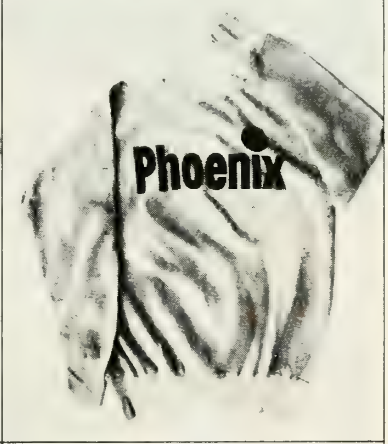

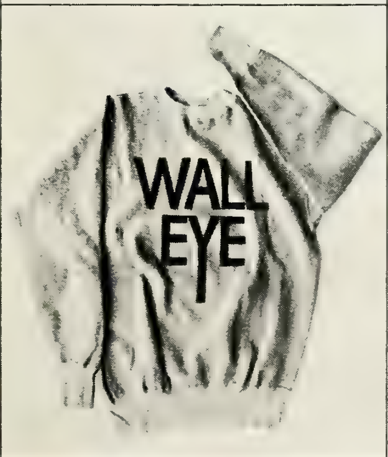

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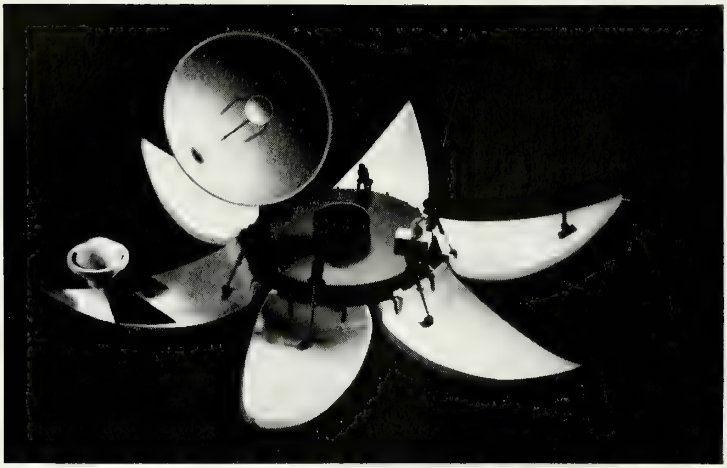

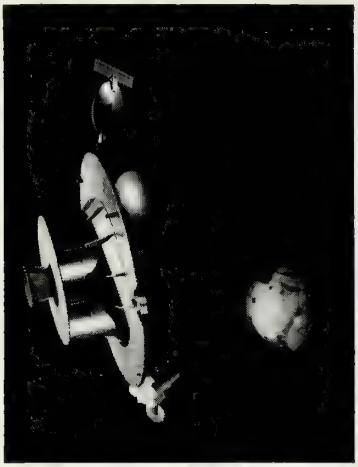

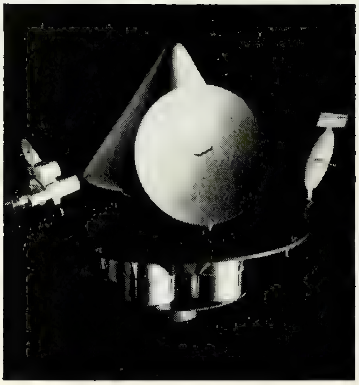

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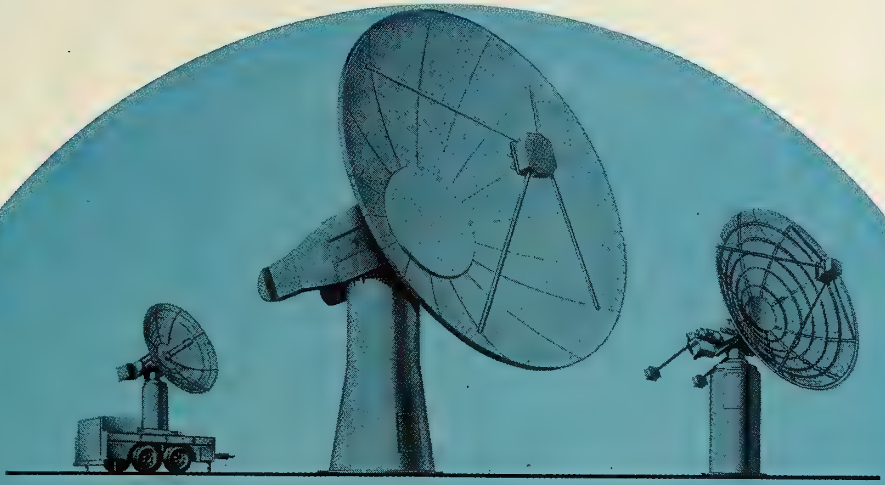

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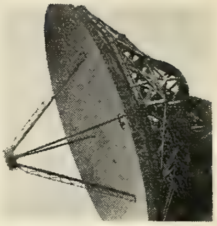
THE COVER

In service position, National Radio Astronomy Observatory's new 140-ft.-dia. radio telescope dwarfs building and vehicles. Precise aiming is achieved by use of two sets of "U" spring industrial brakes that grip ring gears on which movable portion is rotated. See p. 48.



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Editorial 62

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letters

The Ugly American

To the Editor:

Your Oct. 4 editorial ("The Ugly American") was appropriate in content and missing one fact—the name of the NASA public relations official.

Isn't it about time we quit playing games and got this space business down to complete facts, figures—and names, when appropriate?

You are doing a splendid job—let's go all the way!

N. Nelson Carnes
Manager, Contracts Office
Inca Engineering Corporation
San Gabriel, Calif.

Our concern was with the poor public relations handling of a particular occasion, not with a consistent record of poor public relations. If we were writing about the latter, we would not hesitate to name the individual. But to our knowledge no such consistent record exists. Our own relations with the person concerned indicate, in fact, the opposite. We reserve the right to criticize what we believe to be instances of mistaken judgment without castigating, by name, an individual's entire record. —Ed.

To the Editor:

Your Oct. 4 editorial reports yet another manifestation of a truly shocking phenomenon. Throughout industry and, worse yet, the academic world, ancillary personnel are "taking over." They forget that their rôle is to serve the institutions which employ them, rather than vice versa.

Benjamin B. Winter
Costa Mesa, Calif.

260-in. Environment

To the Editor:

You certainly captured a spectacular view of the Aerojet-General 260-inch firing for your Oct. 4 cover picture!

The balloons shown in the picture support microphones—part of the instrumentation installed by us to monitor acoustic, vibration and radiation levels generated by the rocket. This is in support of a continuing NASA program to define the environment generated by these super boosters.

Incidentally, the tremendous size of the plume can be realized when you note that these balloons are flying at just under the 1,000-foot level.

Roland S. McGee
Manager of Marketing
Datacraft, Inc.
Gardena, Calif.

LEM's Orbit

To the Editor:

Will the Lunar Excursion Module be parked in a long-life orbit around the Moon, or a long-life figure eight orbit around the Earth and Moon, after its mission is completed, permitting its reuse or recovery at some future time? If not—why not?

Wilfred T. Ussery
San Francisco

Present Apollo plans call for LEM to remain in orbit around the Moon after its mission is completed. Because of the low gravity of the Moon, it is expected to stay in that orbit for as long as 1,000 years. The module has no heat shield, and there are no plans to attempt to bring it back to Earth. Redesigning it to accommodate a shield would add an unwarranted amount of weight—and NASA feels that in any case the technology within a few years will have far surpassed LEM.—Ed.

The Naked Country

To the Editor:

The case of the *LASV* (Editorial, "The Naked Country," M/R, Sept. 20) is not unusual. Soon after the atomic bombardment of Japan in 1945, I informed the Establishment that "ionized particles in gaseous colloidal suspension" (smoke) provided protection from nuclear explosions and this is documented in my biography in Vol. 5, Who's Who in Commerce and Industry, published in 1946. *Ten years later*, in 1955, the U.S. Army reported the successful application of my basic concept.

As tersely stated in the editorial of the September, 1965, issue of *Electronic Products:* "Present organizations of engineers are too often characterized by self-perpetuating hierarchies, heavy social programs, a reluctance to rock the boat, and overly specialized and windy technical sessions which rarely reveal anything new."

Worrying by the Army over the Russian development won't do any good, but a determined shortening of the line of responsibility certainly will.

Harry Bricker Fuchs
Farmingdale, N.Y.

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REPRINTS of the latest edition of the MISSILES AND ROCKETS *Astrolog, which appeared in the Sept. 13 issue, may be obtained from:*

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IMPORTANT OPENINGS FOR ENGINEERS AND SCIENTISTS ON AMERICA'S MAJOR SPACE PROGRAMS

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- LEM descent engine
- Gemini and Apollo mission analysis
- OGO satellites
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- Pioneer interplanetary spacecraft
- Communications Satellites
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- Vela nuclear detection satellites
- Mars mission studies

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The Countdown

WASHINGTON

TOW Leads in Helicopter Contest

Though no decision has been made as to which missile system will be put aboard Army helicopters, DOD sources tell COUNTDOWN that the tube-launched, wire-guided *TOW* currently enjoys an edge over the gun-fired *Shillelagh*, mainly because of the former's lesser weight. The Army last week awarded Hughes Aircraft Co., prime contractor on *TOW*, a $4,178,655 contract for six months of research on use of *TOW* aboard helicopters.

Out of the Spacecraft by Christmas?

Unofficial launch date for NASA's *Gemini 7* spacecraft is Dec. 8. This would permit the astronaut crew to complete the 14-day mission shortly before Christmas. Plans call for erecting the *Titan II* launch vehicle on Pad 19 at Cape Kennedy "within a week" after the *Gemini-Titan-Agena 6* launch, now scheduled for Oct. 25.

First Apollo Crew To Be Named Early in '66

Selection of crew members for the first manned *Apollo* mission will be announced soon after the first unmanned shot in the program, officially slated for early next year, COUNTDOWN has learned. First manned mission, due "in early 1967," may be one week in duration, with Gordon Cooper the "likeliest candidate" for command pilot.

Navy Ponders New Condor Proposals . . .

A Navy source evaluation board is now reviewing Phase II proposals from North American Aviation and Northrop for the air-to-surface *Condor* missile. Proposals were turned in Sept. 24. *Condor* is a TV-guided long-range stand-off weapon (see story, p. 18).

. . . And May Use AS-12 for ASW Work

Feasibility of employing the French *AS-12* air-to-surface wire-guided missile aboard some of its "older" ASW aircraft is being evaluated by the Navy. Intent is to provide these planes with a weapon affording some stand-off firing range capability for added protection.

Booster Seen Doubling as SST

A recoverable orbital launch system (ROLS) whose first stage would also serve as a Mach 3 supersonic military transport could be available in the early 1970's, according to a study done by the Air Force's Missile Development Center. Second stage of the ROLS would be a rocket-propelled space vehicle. Such a system could produce high orbital payload and satisfy mission requirements of orbital rendezvous or intercept, the Air Force says. An added advantage: its cost-effectiveness looks favorable.

Tether Enthusiasts Plan New Systems . . .

Successful use of a tether for maneuvering outside *Gemini 4* by astronaut Ed White has led to increased interest among NASA researchers in this method of locomotion and control. Spokesmen say possibilities include a system combining a tether line and propulsion unit.

. . . But Pilots Would Like to Get Loose

Decision not to allow untethered extravehicular activities in the *Gemini* program has created some chagrin among astronauts. Walter Cunningham, for example, says one good reason for experimenting without the tether would be to practice the emergency EVA mode of transfer from the *Apollo* Lunar Excursion Module to the Command Module —a necessity in event of a rendezvous failure.

Apollo Delay Snarls '65 Launch Plans

Space agency officials were expected late last week to accept the *Apollo* spacecraft 009 from North American Aviation's Space and Information Systems Div. The spacecraft will be shipped to Cape Kennedy this week, slightly later than planned. This apparently rules out a launch by the *Saturn IB* booster before the end of the year.

Titan III-X Redubbed III-B

Designation of the Air Force *Titan III's* liquid configuration has been changed from *Titan III-X* to *Titan III-B*. The vehicle, without solid-motor strap-ons, will be used to launch a secret payload from the Western Test Range, where construction of its launch facilities is continuing.

Date Nears for Nuclear Test near Siberia

U.S. scientists are slated to detonate a deep underground nuclear blast on Oct. 27 at Amchitka Island, near the western end of the Aleutians. Test is the first under Project Longshot, part of the DOD effort to improve detection of clandestine underground tests and to gather data on long-distance travel times of seismic signals. Site is near the Soviet's Kamchatka Peninsula, an area of considerable seismic activity. It is also well known that it is in the approaches to the Kamchatka region that the USSR is most "seismically accessible."

INDUSTRY

NAA Apollo Award Altered

Development of spacecraft for the *Apollo* Applications program is almost certain to be awarded to North American Aviation, Inc., under an incentive-type contract. NASA and North American late last week completed negotiations but switched the original contract for development of the *Apollo* spacecraft from a cost-plus-fixed-fee to an incentive category. *Apollo* Applications spacecraft are expected to be added to it later. NASA now plans to begin hard negotiations leading to a similar change in Grumman's contract for the Lunar Excursion Module.

INTERNATIONAL

Italians Launch Hawks Against Low Drones

For the first time in Europe, surface-to-air *Hawk* missiles are being launched against target drones flying at low levels. The missiles, assembled in Italy, are being fired by Italian Army anti-aircraft personnel during their final phase of training.

No Design Changes for SL-2

Performance of the nozzle, throat, case, liner and all other components of the 260-in. half-length solid motor fired by Aerojet-General last month was completely successful.

As a result, Richard F. Cottrell, manager of Aerojet's Solid Rocket Operations in Sacramento, Calif., says there were no marginal conditions that would lead to any major change in the design plans for SL-2, the second big solid scheduled for firing early next year.

Confirmed details on the NASA/Aerojet firing Sept. 25 included a peak thrust of 3.57 million lbs.; average thrust of 3.16 million lbs.; action time of 128.2 seconds; and a web action time of 113.6 seconds. The total power generated by the motor was 373.5 million lbs. (force seconds).

Cottrell added that the successful firing is engineering proof that large solid rockets are feasible.

U.S., Soviets Sign Science Pact

The U.S. and the Soviet Union are expected to greatly increase the exchange of scientific information as a result of a new agreement signed last week.

The two nations will jointly publish information on effects of space flight on men and other living organisms, the U.S. has announced. It was also disclosed that the Soviet Union will be ready "within a few months" to implement a 1963 agreement to exchange weather satellite information.

The space biology agreement has been viewed as a Russian acknowledgement that the U.S. has as much information to share in this area as the Russians.

Until the three manned *Gemini* flights were made this year, the Soviet Union was estimated to have had almost 10 times as much manned spaceflight experience as the U.S.

No Solids Yet for Saturn IB

No decision has yet been reached at NASA on the use of solid propellant motors with the *Saturn IB*, either as strap-ons or as a replacement for the present H-1 liquid first stage, according to Adelbert O. Tischler, director of the Chemical Propulsion Div. of the space agency's Office of Advanced Research and Technology.

In the event such a go-ahead should occur in the near future, however, Tischler says that he favors the use of a single 260-in. solid in place of the vehicle's H-1 booster engine. Such a substitution, along with an uprated second stage, would result in a payload capability roughly twice the present 35,500 lbs., according to Tischler.

The chemical propulsion chief says no new high-energy upper stage will be sought in the FY '67 budget, however, and that Phase II development of the 260-in. solid has not received approval.

Over the next decade, at least, Tischler believes that NASA's use of big solids will be restricted to *Saturn IB* and *V*. The development costs of any new systems would be too great to be economically feasible, he indicated.

GTA-6 TV Remains Uncertain

A decision on possible television coverage of the recovery of *Gemini 6* astronauts is expected, pending analysis of tests conducted aboard the USS Wasp (M/R, Oct. 11, p. 10).

Telecommunications equipment provided by International Telephone and Telegraph Corp. was tested with the *Early Bird* satellite and the receiving station at Andover, Me., last week. Columbia Broadcasting System, representing a pool of broadcasters, selected ITT to work with Communications Satellite Corp. on a "no precedent" basis for the *GTA-6* flight. Test data will be analyzed for audio and video signals and possible RF interference with the tracking ship's communications equipment.

Thiokol Gets $16-M Award

Thiokol Chemical Corp.'s Reaction Motors Div. has been selected to develop a 100-lb.-thrust rocket engine for the Marshall Space Flight Center.

The C-1 engine will be developed under a multiple-incentive contract, worth an estimated $16 million. The engine will be used in spacecraft attitude control and maneuvering systems and for launch vehicle ullage and attitude control systems. It will be powered by storable liquid propellants, nitrogen tetroxide with either monomethylhydrazine or a blend of unsymmetrical dimethylhydrazine and hydrazine, NASA said.

The space agency also awarded two contracts for computer services. Telecomputing Services, Inc., will provide computer operations and data processing services at Goddard Space Flight Center under a $4-million, two-year award.

Lockheed Electronics Co. has been named to provide computer, programming and operational support services to the Manned Spacecraft Center. The cost-plus-award-fee contract will be negotiated for a 1-year period with provisions for two additional 1-year renewals. Estimated cost for the first year is approximately $3 million.

NASA-Comsat Talks To Begin

NASA and the Communications Satellite Corp. are expected to begin negotiations this week on a satellite communications system for use in the *Apollo* program.

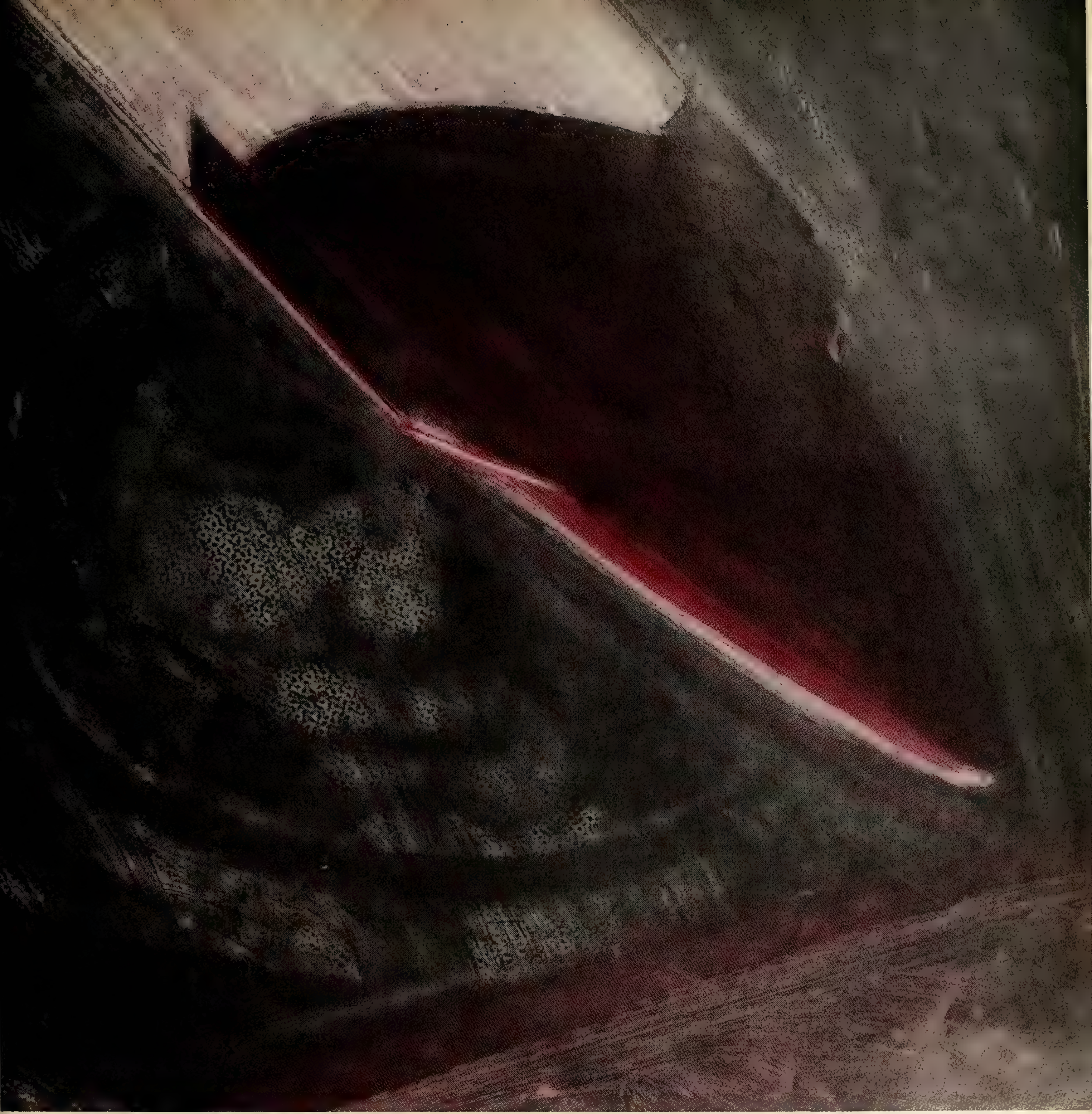
The space agency has announced it will provide up to $6 million between now and Jan. 1 for initial work on the synchronous satellite system. Comsat earlier asked the Federal Communications Commission for permission to contract with Hughes Aircraft Co. for construction of the satellites (M/R, Oct. 11, p. 12). The Comsat board of directors was expected to get the go-ahead for negotiations at a meeting Oct. 15.

NASA, acting as a representative of the National Communications System, has asked Comsat to provide a data link for tracking and data acquisition in the *Apollo* program. The request calls for six reliable 3-kc voice channels to service three tracking ships in the Atlantic, north central Pacific and Indian Oceans and land stations at Carnarvon, Australia, Ascension Island and the Canary Islands. The facilities are to be operational by September, 1966—about the time of the first manned *Saturn IB-Apollo* mission.

In other action, the FCC authorized Comsat to construct ground stations near Oahu, Hawaii, and Brewster Flat, Wash. (M/R, July 19, p. 10). The action was termed a partial grant for the stations "intended for use in conjunction with an *Early Bird*-type satellite between Hawaii, Japan and the western Pacific."

New Asroc Work To Total $22M

The Naval Purchasing Office in Washington is preparing bids on several portions of the *Asroc* missile system, with a total of about $22 million in new business expected to result.



HE PROBLEM OF TRANSPORTING MAN TO THE PLANET EARTH

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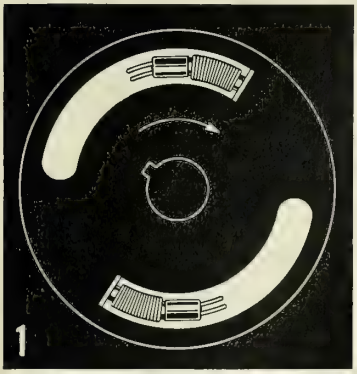

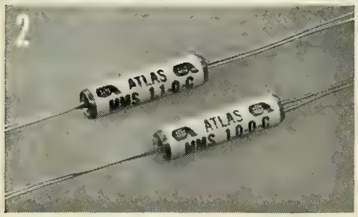

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About $9 million of this will be related to missile components other than those associated with the launching group and air frame. Much of this will be restricted to small business firms. *Asroc* airframe components are expected to account for $900,000 in new business, and roughly $13 million will be associated with launching group components.

Tracking Snags Affected OGO

Main problem encountered during pre-launch preparations for the second *Orbiting Geophysical Observatory* lay in establishing communications with the Western Test Range tracking ship USS Wheeling and with the South African tracking station at Johannesburg.

Because the first *OGO*, launched last year, failed to deploy properly and was rated a failure on this account, the injection and deployment of this second vehicle in the six spacecraft series was planned with special emphasis on maximum return of data and maximum command capability. A ground communications failure would have halted the launch.

"It is very necessary to get early tracking data and information on the progress of the spacecraft so that if performance is not normal, the proper events can be commanded," said Robert H. Gray, NASA launch director for the *OGO-C* spacecraft (also called *POGO* because of its polar orbit), speaking at a pre-launch briefing here. Launch of *Thor-Agena* vehicles for NASA over the Western Test Range is carried out by the 6595th Aerospace Test Wing, Air Force Systems Command.

By using a *Thrust-Augmented Thor* booster for the first time, NASA aimed to achieve observatory injection with a single burn of the upper stage *Agena*. This would have allowed orbit injection within sight of WTR.

Shots of the Week

France's two-stage *Saphir* rocket reached an altitude of 720 mi. Oct. 9, according to reports from the French Armed Forces Ministry. The launch from the Hammaguir rocket center was termed satisfactory. The *Saphir* will be used next month to orbit the first French satellite, *A-1*.

- A *Minuteman II* ICBM launched from Vandenberg AFB, Calif., Oct. 6 lofted its re-entry vehicle into Eniwetok Lagoon, 4,500 mi. down the Western Test Range.
- The Soviet Union on Oct. 12 announced the successful completion of a series of missile launches into the Pacific. The warheads were said to have impacted with great precision.

Pinson New OAR Chief

New commander of the Air Force Office of Aerospace Research is Brig. Gen. Ernest A. Pinson, a former deputy commander of OAR.

Pinson replaces Maj. Gen. Don R. Ostrander, who is retiring from the Air Force after 28 years in service. Also joining OAR as deputy commander will be Col. James C. Dieffenderfer, a former assistant for technology with the Air Force's Research and Technology Div.

Apollo Range Craft Awarded

A Douglas-Bendix team has been awarded a $27,320,199 contract by the Air Force's Electronic Systems Div. to modify eight Air Force C-135 aircraft to serve as *Apollo* Range Instrumented Aircraft.

These craft, which will operate within both Eastern and Western Test Ranges, will monitor spacecraft launch and re-entry phases and will be used for Air Force projects in addition to the primary NASA *Apollo* role. The winning team is expected to take about 2 years to complete the task.

Douglas will handle airframe modification and testing, with Bendix responsible for the electronics. Collins Radio and Lockheed were the losing team in the competition.

Sealab Follow-up Planned

The Navy is planning a manned underwater laboratory to operate at depths between 400 and 450 ft. within the next year as a result of the Sealab II program.

The Sealab project was successfully concluded Oct. 12 when the third team of 10 men returned to the surface after 15 days. Twenty-eight men spent a total of 45 days in the 57-ft.-long capsule anchored 205 ft. below the surface off the coast of La Jolla, Calif.

Cmdr. M. Scott Carpenter, NASA astronaut on loan to the Naval program, spent a total of 30 days in the capsule.

According to Capt. George Bond, chief scientific investigator of the program, the experiment yielded valuable information about the science of underwater living that has greatly advanced the Navy's man-in-the-sea program. Stepped-up exploration of the underwater continental shelves is expected.

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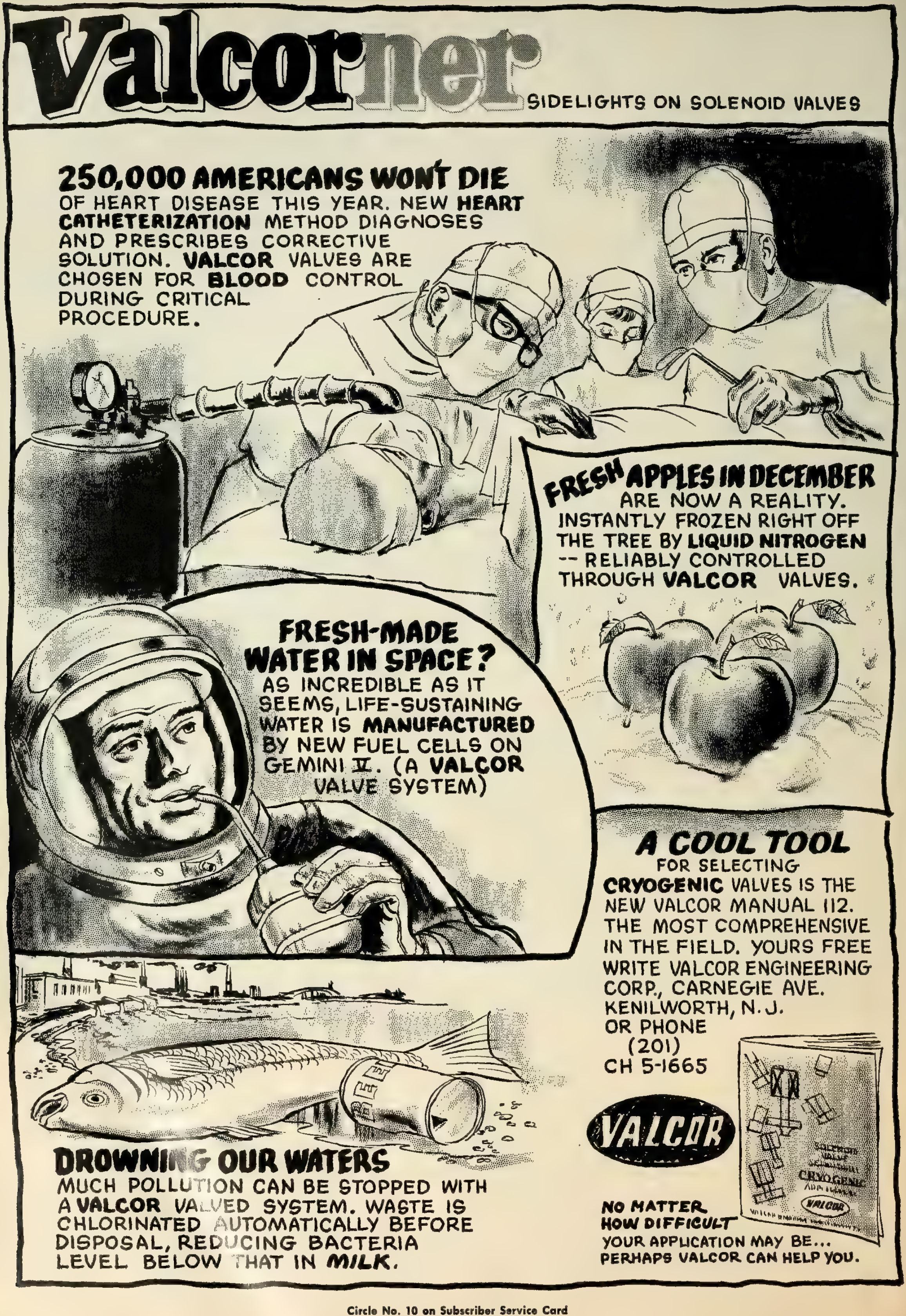

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Aerospace Corp. Given MOL Task

Schriever reveals technical management role at AIAA meeting; AF to buy about eight Gemini capsules; manned ferry detailed

by Hal Taylor

ST. LOUIS—Gen. Bernard A. Schriever declares that the Aerospace Corp. will play a major role in management of the Air Force's *Manned Orbiting Laboratory* program.

Schriever, Air Force director of the *MOL* project and commanding officer of Air Force Systems Command, told MISSILES AND ROCKETS that Aerospace Corp.'s involvement in the *MOL* program would be similar to the role it plays in other Air Force development projects—i.e., overall technical management of systems and subsystems.

Schriever also said he expects the Air Force to buy about eight *Gemini* spacecraft from McDonnell Aircraft Corp., which built the two-man capsule originally for NASA. Noting that Air Force plans already call for six flights in the program, he indicated that it was possible that not all the spacecraft would be brand-new models. He apparently was referring to the *GT-2* spacecraft, which McDonnell is refurbishing under a $5-million Air Force contract. The spacecraft was launched on a ballistic flight during the second mission in the NASA spaceflight series.

- **GT-2 modification begun**—McDonnell officials report that the spacecraft is already on its production line being modified for Air Force use. It will be launched early in the program in an unmanned flight designed to test the feasibility of an escape hatch cut into the heat shield to permit *MOL* astronauts to move from the spacecraft into the laboratory canister.

Queried as to whether there were any plans for *MOL* launches from areas other than the Western Test Range, Schriever said that it was possible, "but no final decision has been made."

He said that many of the decisions would be made in a series of meetings with the *MOL* contracting team on the West Coast. These meetings, apparently with Douglas Aircraft Co. and General Electric Co., prime contractors for *MOL* and its experiments, respectively, were scheduled for the latter part of last week.

Schriever appeared in St. Louis as the featured speaker at the Fourth Manned Space Flight Meeting of the American Institute of Aeronautics and Astronautics. About 700 representatives of the aerospace industry, Government and members of the academic community heard a host of papers read on the status of current and future U.S. manned spaceflight programs.

Some of the highlights were:

Brig. Gen. Joseph S. Bleymaier, commander of the Western Test Range, revealed that the Air Force's *START* (Spacecraft Technology and Advanced Re-entry Tests) program will have four parts—*ASSET, PRIME, PILOT*, and design of a vehicle with a lift/drag ratio of 2.7. The total program, he said, will demonstrate feasibility of a manned ferry spacecraft that will be able to travel at hypersonic speeds.

NASA's Office of Manned Spaceflight has established a Manned Spaceflight Experiments Div. at headquarters which will be under the direction of Douglas Lord. Similar offices will be set up at other NASA field centers. It is these offices that firms or individuals wishing to develop experiments for *Apollo, Apollo* Applications and other future manned programs should contact. The offices will be responsible for the technical and management direction of the experiments up to the time they are assigned to a definite program.

Franklin Dixon, director of the Office of Manned Planetary Studies, said it would be at least two years before NASA would have to make hard deci-

Saturn V May Boost Two Voyagers

A NASA RECOMMENDATION under consideration by Administrator James E. Webb calls for launching two *Voyager* spacecraft toward Mars using a single *Saturn V* launch vehicle.

Each payload would include a spacecraft bus, a capsule landing system and a retro-propulsion unit. Each of the two payloads would weigh about 20,000 lbs., or a total of 40,000 lbs., which is just about the total payload capability of the *Saturn V* on missions to Mars.

The proposal by the Office of Space Sciences and Applications (OSSA) is part of the complete shake-up of the *Voyager* program dictated by new data gathered by the *Mariner IV* spacecraft last July.

Information indicating that the atmospheric pressure near Mars may register as low as 5 to 10 millibars has resulted in major redesign of the capsule landing system.

OSSA officials decided to scrap plans for a 10,000-lb. *Voyager* spacecraft—to be launched by the *Saturn IB-Centaur* launch vehicle—because the retro-propulsion system would have taken up so much of the payload that the lander's ability to gather scientific data would have been sharply reduced.

The switch to the *Saturn V* will permit an additional 10,000 lbs. to be used for the retro-propulsion system and the capsule lander.

If the plan is approved by top NASA management, it will mark the first time that two such heavy spacecraft—or any other spacecraft—have been launched at such a distant target as Mars with the same launch vehicle.

The re-organization of the *Voyager* program, in addition to scrapping the *Saturn IB-Centaur,* also calls for dropping plans for a test flight of the *Voyager* system in 1969. It is also expected that the switch will mean a step-up in plans for a single *Voyager* spacecraft landing system that would weigh about 40,000 lbs., including a sophisticated automated biological laboratory.

A final decision on the re-organization is apparently being delayed by consideration of NASA's Fiscal Year 1967 budget by the Bureau of the Budget. While action is imminent, no NASA official will allow himself to be pinned down as to exactly when the announcement will be made.

Another proposal which has been made for a change in the *Voyager* program calls for using a *Mariner* spacecraft to launch a small probe into the Martian atmosphere to gather detailed data on its pressure.

This could serve to settle a controversy in the scientific community as to whether the lowest pressure is 5 or 10 millibars. The data would also be used for final design of the capsule landing system.

sions even on such matters as systems definition for such programs as a manned Venus or Mars fly-by mission. He said early decisions were precluded by the lack of funding for such programs until the current *Gemini* and *Apollo* funding drops off and real starts are made on the *Apollo* Applications and *Voyager* programs.

- **Apollo flight change**—William E. Lee, assistant manager of the *Apollo* Project Office at the Manned Spacecraft Center, said that a change in *Apollo* plans calls for the use of the Hohmann lunar descent trajectory, which will lengthen the trans-Earth transfer time and enable the rendezvous of the Command and Service Modules with the Lunar Excursion Module on the near-Earth side of the Moon. This will also slightly lengthen the total mission time for the first U.S. manned lunar landing flight.

E. R. Spangler, of TRW Systems Group, warned that removing man from his natural environment for long periods during extended manned missions may prove to be harmful. He said that there is concern that man may be adapted in a critical fashion to rhythms or recurrences that are not now recognized. Interruption of such rhythms could have a harmful effect.

In discussing the *MOL* program as the next step in space, Schriever said that it does not exist in isolation from other military developments in space and it certainly does not exist in isolation from the NASA programs.

"I stress this point because I think it is high time for people to stop trying to divide the national space effort into a series of airtight little compartments, each of which is labeled peaceful or non-peaceful. In actual fact, all of our space programs serve peace, either through helping deter aggression or through yielding scientific, technical and economic benefits."

Schriever's statement that Aerospace Corp. would play a significant role clears up any doubt about the future of that non-profit institution's function in Air Force projects triggered by a recent Congressional investigation and criticism of the firm's management.

(Aerospace Corp. announced Oct. 14 it has established a *MOL* systems engineering office reporting directly to Dr. Allen F. Donovan, senior technical vice president. Under company contract with the Air Force Space Systems Div., the office is providing general systems engineering and technical direction for the program.)

(Dr. Byron P. Leonard, vice president and associate general manager of El Segundo, Calif., technical operations, was named general manager of the *MOL* office.)

- **START details**—Bleymaier said the *START* program is a step in the direction of maneuvering re-entry. It represents a technological attack on one of the limitations on U.S. manned space programs—the inability to re-enter and land a spacecraft when and where it is desired.

ASSET, the first phase, has tackled the problem of overcoming the limitations of ballistic re-entry by proving the materials for maneuvering spacecraft.

The second part—*PRIME* (Precision Recovery Including Maneuvering Re-entry) calls for four unmanned sub-scale vehicles to be launched by an *Atlas* booster from the Western Test Range at near-orbital speeds. Plans call for a 700-n. mi. cross-range maneuver, providing a recovery footprint 1,400 n. mi. wide and 3,200 n. mi. long. Aircraft recovery of the 8-ft.-long test vehicle is planned near Kwajalein Atoll in the Pacific Ocean.

Gen. Bleymaier said that once *PRIME* is accomplished, the Air Force hopes to continue with the third stage of lifting body testing—the *PILOT* portion (Piloted, Low-speed Tests). Although this has not yet been approved, plans call for fabrication of a manned lifting body that would be launched in *X-15* style by a B-52 from Edwards Air Force Base.

Using small rocket engines, the *SV-5-P* vehicle could accelerate to Mach 2, and by skimming the edge of space, could demonstrate the transonic and subsonic maneuvering of the lifting body.

"Assuming that *PRIME* and *PILOT* are successful," Bleymaier said, "we should have all the data and technology needed to design the manned ferry spacecraft of the future." The fourth part of the *START* package would consist of two design studies of a vehicle with a lift/drag ratio of at least 20%. This, he said, would give the U.S. a vehicle capable of de-orbiting at any time and landing anywhere the pilot chooses.

- **Cosmic puzzles**—In discussing biorhythm interruptions, Spangler called for a major research effort to understand what dangers may be faced by removing man from his natural environment for substantial periods. He said that animals and plants are rhythmic systems, and that there is reason to believe that man may be affected by the same forces.

As an example, he said that fiddler crabs removed from salt-water beaches still respond by some unknown mechanism to the tidal variations of the specific beach from which they were removed.

As far as man is concerned, he said, statistically significant correlations exist between cosmic ray activity and admissions to psychiatric hospitals and between cosmic ray activity and the ebb and flow of psychotic behavior of patients in psychiatric wards.

He said that these phenomena do not necessarily point to inherent dangers in man's removal from the Earth for prolonged periods, but do point to the fact that consequences of the removal are unknown in many respects. ■

Apollo Applications To Include LSSM

NASA NOW EXPECTS to select a lunar surface survey module (LSSM) concept shortly after July 1, 1966.

While final approval for the program is not expected until about the second quarter of next year, most NASA officials believe it will have to be an integral part of any *Apollo* Applications extended lunar exploration.

Franklin Dixon, director of manned planetary studies and until Sept. 28 also director of manned lunar surface studies, says that if approval is given, selection of the prime contractor will be made early in Fiscal Year 1967.

He said that four concepts are now under study by General Motors Corp., Bendix Corp., Grumman Aircraft Engineering Corp., and Bell Aerosystems. The GM and Bendix modules would weigh about 1,000 lbs. and differ only in the number of wheels on the vehicle. GM's design has six wheels while Bendix's has four. Grumman's effort in the area is a company funded program. Bell is working on a lunar flying concept.

Dixon said that an *Apollo* Applications lunar surface mission would call for two launches of the *Saturn V*. One would carry the Lunar Excursion Module shelter with the LSSM onboard. The second launch would carry the astronauts to the lunar surface and they would return in the same LEM.

A logical program for lunar exploration with *Apollo* Applications systems would first of all call for 28-day flights in lunar orbit. Then would follow four and perhaps as many as six extended-duration stays of up to 14 days on the lunar surface, Dixon says. A mobile laboratory (MOLAB) could then be used to extend stay times to as much as a month. Then, if it was feasible, a lunar base with a duration of up to three months might be constructed.

New Suit To Be Worn Aboard Gemini 7

'Get-me-down' garment provides ventilation and cooling, blast protection, emergency pressurization; no-suit concept dropped

by Jinx Mercer

HOUSTON—*Gemini* program officials have abandoned the "true shirtsleeves" (without spacesuits) concept proposed by astronauts for the 14-day mission in mid-December.

Instead, *Gemini 7* pilots Frank Borman and James A. Lovell will wear lightweight, flexible spacesuits which have been designed for comfort and mobility. Appropriately termed "get-me-down" suits by flight crew members, the garments provide adequate protection in the event of abrupt loss of cabin pressure and "satisfactory" pressurized mobility to control the spacecraft during an emergency re-entry through the atmosphere.

Details of the suit were presented in a technical paper co-authored by Richard S. Johnston, James V. Correale and Matthew I. Radnofsky of the Crew Systems Div. of NASA's Manned Spacecraft Center for presentation at the American Institute of Aeronautics and Astronautics meeting in St. Louis.

The "intravehicular" suit was developed by MSC's Crew Systems Div. and built by the David Clark Co. of Worcester, Mass.

The paper says a change in the *Gemini* program which dropped extravehicular activity (EVA) from long-duration missions "made possible the consideration of a suit used strictly for intravehicular operations emphasizing comfort, reduced bulk, and unpressurized mobility." Other considerations, the authors added, "were crew's adverse comments on bulk and mobility as an imposition on the 14-day flight."

- **Suit advantages**—Although confident that the *Gemini* spacecraft cabin pressurization system would permit a true shirtsleeves environment, NASA felt that the spacesuit had things to offer, namely ventilation and cooling and protection against blast during ejection seat escape, along with emergency pressurization. This prompted officials to abandon the shirtsleeves concept, the authors indicated.

The one-piece suit includes a zipped-in, soft cloth hood with a built-in polycarbonate visor. Under the hood, each pilot will wear a standard fighter-pilot helmet for impact and shock protection. For helmet-off communications, a lightweight headset will be provided.

Major modification is elimination of the large rotating neck-bearing and helmet-attaching system used on earlier *Gemini* suits. This not only provides additional comfort to the wearer, but also permits quicker emergency donning.

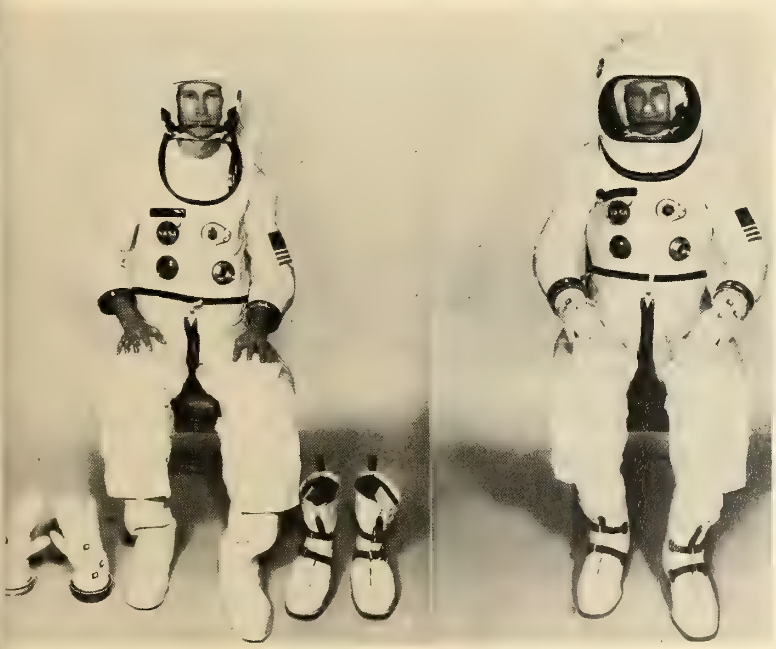
The suit consists of two layers of material: a pressure-retaining layer of neoprene-coated nylon and a cover layer of six-ounce high temperature (HT-1) nylon. Small sections of link net have been added to the shoulder areas to improve mobility. For ventilation, the suit utilizes an external ducting system to the arms and legs.

Outer jump boots may be removed in flight without reducing suit-pressure integrity. The boots are described as "soft," with ankle restraints and neoprene soles. Glove removal requires disconnecting wrist bearings.

The suit weighs 16 lbs., including the 4-lb. crash helmet. The *Gemini* G-3C suit, worn by *Gemini 3* pilots Virgil I. Grissom and John A. Young, weighs about 24 lbs.

Because the new suit is less bulky than the earlier *Gemini* garment, it is possible to remove it completely even within the confining *Gemini* cockpit, the authors said. However, they did not indicate whether *Gemini 7* pilots plan to do so during the two-week mission in December.

Estimated cost of the lightweight suit is $180,000, according to an MSC spokesman. The figure includes fabrication of 13 G-5C production spacesuits by David Clark Co. at $10,000 per unit cost, he added, and approximately $50,000 went into research and development. ■



G-5C SPACESUIT to be worn by Gemini 7 astronauts is modeled by Fred Spross, suit engineer with Crew Systems Division of NASA's Manned Spacecraft Center. Photo at left shows suit in unpressurized mode; pressurized mode is demonstrated at right. "Intravehicular" suit was developed by Crew Systems Div. and built by David Clark Co.

DOD Re-evaluates Tactical Missiles

Viet-Nam aircraft losses force Air Force, Navy to consider development of longer-range conventional air-to-surface weapons

by Michael Getler

U.S. AIR FORCE AND NAVY experience in air operations over North Viet-Nam is causing defense planners to take a hard look at use of conventionally armed tactical ballistic missiles for some missions now assigned to aircraft.

Development of future U.S. air-to-surface missiles is also certain to be profoundly affected by experience gathered in Viet-Nam, both in the types of U.S. weapons used and the evasion of enemy defensive weapons.

Since bombing of North Viet-Nam began in February of this year, 104 U.S. aircraft have been shot down over the North, according to Dept. of Defense figures. While only four of these aircraft have been downed by Soviet-built *SAM-2* (surface-to-air missiles), tactical warfare experts point out that "it is the threat of the *SAM's* that is forcing our aircraft down to lower altitudes where they have run into stiff and effective conventional anti-aircraft gun fire."

As one official states: "The guys who couldn't afford their own missiles never gave up their guns, and now we have to relearn some of our old tactics. Frankly, we were better prepared to meet an airborne threat to our air forces."

- **Changes imperative**—DOD experts say that it is a moot point whether or not attrition rates of aircraft in Viet-Nam are too high, or are normal when viewed with respect to numbers of sorties flown. In any case, different tactics and new weapons are needed to cut losses and provide more effective attack capability.

The new weapons will include air-to-surface missiles with greater stand-off delivery range and anti-radiation missiles with wider frequency coverage and improved countermeasures capability. Perhaps most important, they may also include surface-to-surface tactical ballistic missiles armed with conventional warheads.

There also are old lessons to be reviewed in the application of armor plate to aircraft, planners say, and a major effort is reported in progress in the reduction of aircraft radar cross-section.

The only U.S. air-to-surface missile used in Viet-Nam thus far is the *Bullpup*, a visual/radio command guidance weapon which, in its 750-lb. warhead version, has proved highly effective against undefended targets. However, DOD planners say the weapon and the means by which it must be guided are "not optimum" for well-defended targets. Pilots generally have to fly a steep dive and stay on the target run too long in the face of heavy ground fire.

- **Anti-radiation**—Though U.S. forces have not used anti-radiation missiles to counter missile or gun radars thus far, it is considered likely that they will be used in the future. An early version of the Navy-developed *Shrike* anti-radiation missile was put in limited production, primarily in response to the Cuban missile crisis, where the *SAM* threat was also present. The missile is believed to be suffering from both reliability and antenna problems.

The question of tactics is integral with the use of anti-radiation missiles. For example, as one expert explains, "the enemy can move the *SAM* site fre-

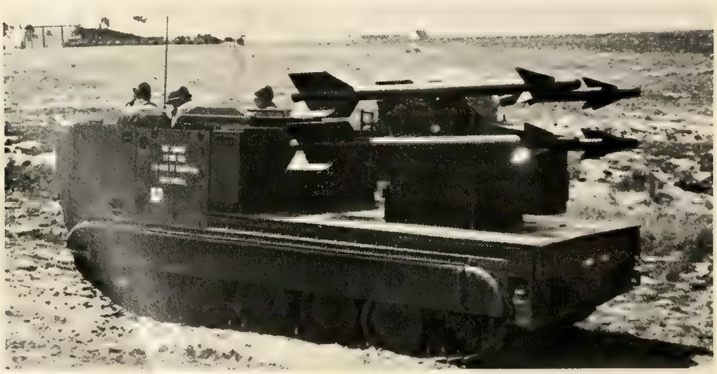
Guided Chaparral Successes Revealed by Army

ARMY HAS ANNOUNCED for the first time publicly successful guided firings of the *Chaparral* forward-area air-defense weapon at the Naval Ordnance Test Station, China Lake, Calif.

Project sources say that a number of firings against targets have been made, and that the missile and its self-propelled mount have completed first phase of development. Major items remaining before production quantities of the missile are ordered are the selection of a 20- or 40-mm automatic gun which will make up the *Chaparral*/gun mixed weapon system, and a final determination as to the level of deployment.

Decision on the gun is expected in the near future, according to project sources. The missile, a modified version of the Navy's *Sidewinder 1-C*, and the gun will be mounted on separate carriers. An early-warning radar, also mounted separately, will be a part of the system.

The system is designed as a low-cost, fair-weather-only defense against low-altitude threats ranging from helicopters to high-performance aircraft. *Chaparral* uses a four-missile launcher, with an optical sight for target alignment. NOTS acts as prime contractor for the missile. Philco's Aeronutronic Div. has *Chaparral* system responsibility. Philco is also developing the launcher turret.



CHAPARRAL's modified self-propelled launcher.

quently, which means that we must be able to take care of that site right after it fires, assuming that it has been undiscovered previously. The enemy also retains the option of turning off his radar at any time." Also, experts note that missiles which sense only radiation are relatively vulnerable to countermeasures, and that aircraft carrying this type of weapon may be identifiable by the patterns they have to fly.

DOD planners believe that the future of these weapons lies in two basic improvements—the expansion of frequency coverage and the inclusion of alternate guidance concepts as a counter-countermeasure device. In a recent speech, Leonard Sullivan, named to the new post of assistant deputy director of the Directorate of Defense Research & Engineering for tactical systems review and analysis, called for "our guidance system experts to develop missile guidance concepts based on virtually every plausible target emanation or reflection for which a sensor currently exists."

The alternate guidance concept is extremely important since it provides the option to attack the *SAM* site or get safely around it to the target.

● **Projects in being**—Several programs already under way represent steps towards DOD's objective of broader-capability missiles, but, as one official puts it: "these do not represent the last word. Also," he adds, "all of these systems were originated under the *threat* of increased enemy antiaircraft capability, not under the *fact*. So," he concludes, "there will be more new ones coming."

Among existing programs are the Navy-developed *ARM-1* anti-radiation missile, the *Condor* long-range stand-off missile, and the *Walleye* TV-guided glide bomb. AF programs in this area include the SOR-215 family of optolelectronic-guided air-to-surface missiles, including the *Hornet* and *Maverick*.

ARM-1, described by DOD planners as "a better all-around missile," is still in the advanced component development stage with no approval yet on a specific missile design. A decision on whether to move into contract definition phase for *ARM* will be made "within a year," DOD sources state.

A decision on the future of the TV-guided *Condor* is expected within the next few months. North American Aviation and Northrop both have early definition-phase contracts. This missile reportedly has the longest stand-off range of any of those now under study, which would make it valuable for hitting SAM-defended targets.

Walleye, production of which is assured, according to informed DOD sources, is now in project definition phase, part of which is competitive. Navy sources report that a decision on source selection will be made "in the near future." *Walleye* is said to have high accuracy and a good stand-off range capability, better than *Bullpup*, even though it lacks a propulsion system. The TV guidance used in *Walleye* reportedly does not have to be monitored in the cockpit—hence, the effectiveness of the weapon is essentially limited by the distance the pilot can stand off from the target. The pilot does not have to stay on the target run as long as he does with *Bullpup*. The weapon is aimed at local targets not protected by SAM sites. Use in Viet-Nam is likely, according to informed sources.

The Air Force is also expected to act soon on the future of *Hornet* and *Maverick*. The newer *Maverick* is a larger weapon than *Hornet*, and presumably has a longer range. Both missiles are still in a pre-contract-definition stage. The Air Force's *Short-Range Attack Missile* (*SRAM*) will be developed initially for SAC use, but DOD experts expect it will also be usable for tactical missions.

The questions of stand-off range, how much is enough and how much can reasonably be achieved in the air, are tied intimately to the possible use of ballistic missiles to accomplish the same job. DOD experts expect important new emphasis to be placed on this concept.

● **Ship-based Lance?**—A first step along this line was taken last week when the Navy let two contracts to study feasibility of using the Army-developed *Lance* field ballistic missile system as a shipboard weapon in support of landing opeartions. DOD planners told M/R they were sufficiently encouraged at the possibilities to support the Navy in its early studies, largest of which went to the *Lance* prime contractor, Ling-Temco-Vought Inc.'s Michigan Div. DOD sources also report that the missile is being considered for a new variety of ships.

Officials say that improvements in missile guidance systems and in lethality of conventional warheads should now enable use of ground-based weapons in situations where nuclear warheads would have had to substitute for the lesser accuracy of early weapons. Planners also see potential nighttime and foulweather advantages for the ground-launched missiles. Target location appears to be the major technical obstacle.

Though *Lance* is said to be the only project which has actually moved into feasibility study, DOD officials say that if aircraft attrition rates in Viet-Nam rise much further, "there will be more people thinking about this and more systems are certain to come forward."

● **Sullivan speaks out**—The growing DOD interest in ballistic missiles to fill some of the more difficult air-strike requirements, and in better airborne standoff missiles, was signaled late last month in the speech Sullivan made to the Society of Experimental Test Pilots in Beverly Hills, Calif.

Sullivan hit at what he considers to be many pilots' traditional overestimation of the aircraft and underestimation of the potential usefulness of missiles. He told M/R that it is difficult to get acceptance for long-range stand-off weapons "until the pilots start calling for help." He also bemoans the fact that basic TV guidance for these weapons was proved feasible several years ago but was not pursued vigorously until the threat of mobile, front-line *SAM's* became real.

Sullivan pointed out that increasing mobility and accuracy of *SAM's* has forced tactical aircraft "to operate in the extreme corners of their flight envelope. We have now reached a stage," he said, "where we are rapidly running out of vertical airspace in which survival flight can be assured. Our current designs optimized around flight at very low altitudes appear to be a last desperate effort to find safe tactical airspace.

"In view of the relative ease of providing at least local defense against low-flying aircraft," Sullivan reported, "it is evident that tactical aircraft will soon be forced to accept the use of stand-off missiles for neutralization and penetration of these defenses."

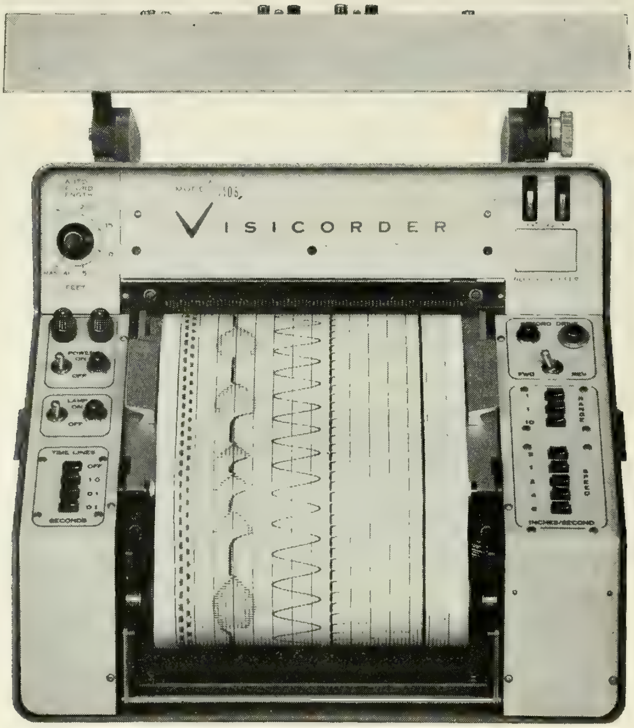
In calling for "far more serious consideration to the development of conventionally armed tactical ballistic missiles," Sullivan also defended against charges of insurmountable target location problems for these missiles and long-range airborne stand-off weapons.

"We are already demonstrating," he stated, "that manned aircraft need extensive sensor equipment themselves—and that the processed sensor data is neither real-time nor presented to the crew of the recce aircraft. Thus, although recce does present a problem to the use of stand-off missiles, ground- or air-launched, it is not obvious that the solution will require human inputs on the spot."

Sullivan asserts that any genuinely adequate reconnaissance system will gather information on many targets in a single pass, probably many more than it could destroy. "If this is valid," he said, "then it also speaks for the continued separation of the recce and attack systems, either of which may be a manned or unmanned vehicle depending upon many considerations."

Sullivan also stressed that new ground and aerial reconnaissance systems must provide target location data in a form suitable to allow follow-up attack by missile systems. ■

SPECIFYING A RECORDING OSCILLOGRAPH?



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Technical Countdown

ELECTRONICS

Laser vs. Umbilical Use Studied

The replacement of some of the cumbersome umbilical cables and complex connectors now in use for large space vehicle launch with an infrared laser beam is being studied by IBM for NASA's Kennedy Space Center. A prototype system now being built by the firm's Federal Systems Division will be used to test feasibility of eliminating all information-carrying wires. The initial dual-redundant system will employ eight gallium-arsenide injection lasers to transmit PCM (for digital data) and PFM (for voice communications). These will replace 112 conventional wire circuits, including two voice links. Photodiodes will serve as receivers.

NASA 3-Mev Accelerometer Available Soon

The Manned Spacecraft Center accelerator laboratory, now nearing completion, will feature a 3-Mev Van de Graff accelerator that will be used by the radiation and fields branch for various radiation experiments and materials studies. The accelerator produces a continuous beam of H^+, D^+, and He^+ ions. MSC said that iron particles 1-micron in size may also be accelerated within the chamber to enable micrometeoroid impact studies on space materials.

Accelerometers Tested To 100,000 G's

Aiming to measure accelerations of vehicles subject to blast loading, Sandia Corp. has developed a means of evaluating accelerometers at up to 100,000 g. An air gun fires a projectile onto an anvil attached to the accelerometer, to provide the required acceleration for durations in excess of 100 microseconds. (Typical natural periods of suitable shock accelerometers are between 8 and 27.8 microsec.) One experimental accelerometer showed a linear increase in sensitivity with g load. Positive zero shift after unidirectional pulses greater than 10,000 g was also noted.

In-flight Ablation Instruments Tested

Flight tests of sensors on a *Scout* re-entry vehicle nose cap composed of *Apollo* heatshield material have shown that an in-flight ablation measurement instrument can be developed. Data on the tests were given by Peter J. LeBel and James M. Russell III, of NASA's Langley Research Center, at the recent 20th Annual Instrument Society of America conference in Los Angeles. A make-wire sensor measured rate of recession of the char layer interface. A light-pipe sensor and a spring-wire sensor measured material surface-recession rates. All three could measure surface position to within 0.01 in. The test was carried out at a re-entry speed of 28,000 fps. Instruments of this type would enable astronauts to monitor performance of their heat shield during re-entry. Future tests will examine sensor performance in simulated lifting re-entry and lunar return.

METRICS

Microinch Calibrator Developed by GM

A completely mechanical device for calibrating instruments that measures displacement to within one or two microinches has been developed at General Motors Research Laboratories. Repeatability of the displacements is within the least reading of the unit, 0.1 microinch. Accuracy is 1.5 microinches over the 1,000-microinch range. Inaccuracies at five light-band intervals across this range are known to better than 0.1 microinch. The device is used to calibrate dial indicators, electronic comparators, and linear measurement transducers.

Telephone Lines Carry Precision Frequency

Transmission of a 1-gc standard frequency over a long-haul telephone line with negligible degradation of accuracy is being achieved from the Downey location of North American Aviation's Autonetics Div. to the division's main plant at Anaheim, 23 mi. away. Typical phase errors of 30 microseconds in the telephone line, as its ambient temperature changes, are cut to less than 1 microsecond by an automatic phase comparator. The leased lines are in multi-pair cable, which is underground for about 56% of the way. Loading coils and repeater amplifiers are removed. D-C resistance of the line is sensed for phase correction, enabling the APC to be located at either end of the line. The system is likely to be expanded to link other North American Aviation operations in Southern California to the Downey cesium beam standard.

PROPULSION

Calorimeters Probe Spacecraft Heating

Thermal environment around the base of *Centaur* when its two 15,000-lb.-thrust engines are firing at altitude contains almost no thermal radiation from exhaust products. Slight convective cooling fluxes are present, due to interaction between recirculated exhaust products and cryogenic vent gases. This report was given at the 20th Annual Instrument Society of America by Emmet H. Christensen, General Dynamics/Convair. This investigation of the environment was effected by onboard commercial foil calorimeters with different optical coatings and spatial orientation. Total heat flux could be separated into solar, albedo, and planetary thermal radiation, low-altitude orbital free molecular dynamic heating, and engine and vented exhaust gas components.

SPACE MEDICINE

Soviets Study Moon Trip Radiation Protection

The Soviet press agency Novosti reports that Soviet scientists have found that radiation conditioning—exposure to periodic small doses of radiation in the 50-60 roentgen range—reduces the biological effects of subsequent irradiation, even in large doses. In addition, Novosti said, the scientists believe that biological effects of ionizing radiation are reduced by g-forces. The work was part of a series of simulations of the radiation conditions cosmonauts may encounter on the way to the Moon. Accelerations were also simulated in the experiment. In another phase, the scientists tested a radiation protection drug, administering it to white mice minutes before smulation of a solar flare. Although bombarded wth a lethal dose of radiation, they report, the animals survived.

Thermionic Space Power Considered

Direct conversion of nuclear to electrical energy being cautiously advanced as superior to Rankine cycle systems

by William S. Beller

THE CONCEPT of converting nuclear energy directly into electrical energy to generate large amounts of space power has almost nosed out the Rankine cycle idea used in the foundering SNAP-50 project.

Congressional, Atomic Energy Commission (AEC), and industry sources are cautiously confirming this finding, based as much on the promise thermionic conversion holds—and possibly has already demonstrated—as on their reticence to back a system that may even now be obsolete.

Rep. Craig Hosmer (R-Calif.), detailing to MISSILES AND ROCKETS the reasons the Joint Committee on Atomic Energy is again recommending to Congress cutting back on money for advanced space power systems, specifically SNAP-50, said: "Other competitors are coming along, which may pass the rotating equipment idea; for example, thermionic devices. . . ." He also noted that loop failures have occurred in SNAP-50 development hardware.

- **Rotating equipment scored**—Taking up the reliability question, R. T. Carpenter, chief of AEC's Isotopic Power Branch, noted that direct-conversion devices are more like solar cells because they can be hooked up in parallel for redundancy and assured system lifetimes. On the other hand, "if you want a 90% probability of a mean time between failure of 120 days, with a 50% confidence level, you have to test the rotating unit for 179 years," he told M/R.

Indicating that such a life test, even if approved, would be expensive for SNAP-50 and would call for a number of rotating units, Carpenter said that the analog in a direct conversion system is the thermionic diode or thermoelectric couple. Life tests on these are relatively inexpensive; on a Martin Co. thermoelectric generator, 23 million thermoelectric couple hours were run, "immensely aiding the solution of the statistical problem of probable lifetimes."

Industry sources working under AEC contract to develop concepts and hardware for high-power, thermionic space-power systems are reluctant to talk for publication about their progress. The two major contractors in this field are General Electric Co.'s Vallecitos Atomic Laboratory, San Jose, Calif., and General Atomic Div. of General Dynamics Corp., in San Diego. Nevertheless, one executive volunteered, "If you can judge success by classification, we're becoming very successful."

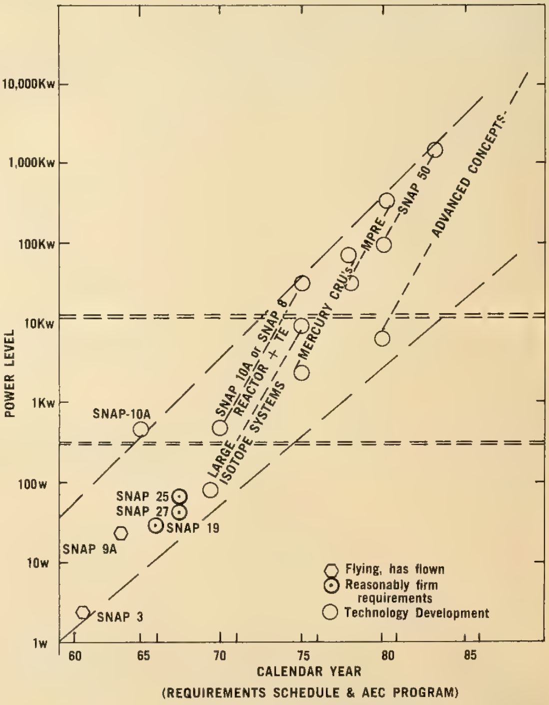
Yet it is no secret that industry has successfully run out-of-pile tests of thermionic diodes, although current reference to this work is now classified. It was disclosed during this year's AEC authorization hearings that in-pile experimentation is also going on and is to be continued. The in-pile system, in which the thermionic diode is part of the fuel element itself, is considered the most efficient way to derive electrical energy from a nuclear heat source. If in-pile diode tests have proven successful, then the feasibility of a system based on the diode is feasible, at least for the power level of the test.

- **Call for modern thinking**—The Joint Committee, seemingly impatient with the slow progress on the four SNAP reactor space projects that have been started—and also the lack of Defense Dept. or NASA requirements for them—is urging the AEC to update its thinking.

"Present SNAP reactor projects are based upon choices of technology made in the mid-1950's," says the committee report accompanying the present AEC authorization bill. The committee urged the AEC "to make a selection or selections of advanced systems based upon present-day technology and estimates of the potential of present-day technology."

Seconding this notion, Carpenter observed to M/R that the "thermionic diode business has come a long way since it was invented in the last decade, exceeding the expectations of many people." He added, "the steam engine has been around a long time." The steam engine and SNAP-50 are both based on the same thermodynamic cycle.

- **Thermoelectric versus thermionic**—In thermoelectric conversion of nuclear heat to electrical energy, the thermocouple is the basic module. In the thermocouple, two lengths of wires of



SPACE RADIOISOTOPE GENERATORS

SNAP No.	Watts	Life (Yrs.)	Wt (lbs.)	Application	Fuel	Status
3	2.7	5	5	Transit 4A and 4B	Pu-238	Launched 6/61 and 11/61. Unit on 4A still powering transmitter signals. Converter on 4B shorted out 6/62.
9A	25	5	27	Navigation satellite (Navy)	Pu-238	First unit launched 9/18/63; second 12/63. Generators operating satisfactorily. Third unit burned up 4/64.
11	25	1/3	33	Surveyor (NASA) (intact re-entry)	Cm-242	Electrically-heated generator delivered to JPL 5/65. First fueled unit scheduled mid-1966. Prototype flight, electrically heated generators to be delivered to Jet Propulsion Laboratory and Manned Space Center in mid-1966.
17	30	3-5	30	Communications satellite	Sr-90	Two generator-design and component-test contracts (Phase I) terminated 11/64. (T/E modules continue under test.)
19	30	5	30	Nimbus-B	Pu-238	Electrically-heated generators on test at Goddard Space Flight Center since 2/65. Flight date 1967. Phase III flight hardware development initiated 9/65.
25	75	5	35	Earth orbital missions Interest from: DOD-comsat use; Weather Bureau-follow on to TIROS NASA (Goddard)-high-powered Nimbus	Pu-238	Cancelled. System developments and advanced technology programs under way or planned adequately cover critcal areas of this effort.
27	50	5	25	Apollo lunar surface instruments packages (intact re-entry)	Pu-238	Two phase I design studies completed. General Electric selected to continue program. Phase II to begin this fall.

two different metals are welded together at both ends. If one end junction is hotter than the other, an electrical current is generated.

In the thermionic module, a diode is used. One of the electrodes is heated to a high temperature—2,000° to 3,000°F—to boil off electrons; these are received by the cooler diode, thereby generating a current.

In the SNAP-50 concept, a nuclear reactor heats a liquid metal; in turn, the metal is expanded through a turbine, which turns a generator and creates electricity. The goal was to develop a powerplant able to generate 300 to 1,000 kw electrical power, with an overall powerplant specific weight of 20 lbs. per electrical kw, unshielded, and 10,000-hour operation.

The proposed SNAP-50 schedule was to proceed to eventual operation in 1972 of a power-conversion subsystem test and an operating powerplant ready for space in the late 1970's or early 1980's.

The work being done in industry in the space thermionics field is geared toward the same power output as SNAP-50 and the same schedule for eventual operation.

A spur that will become increasingly sharp is the Russian work on a space power reactor called Romashka. This was apparent during the September, 1964, conference in Geneva on the peaceful uses of atomic energy when the Soviets reported on their efforts to devise a thermoelectric generator similar to SNAP-10A.

Thermoelectrics, though, cannot reach the power levels of thermionics. "When you go to 200-300 kw, you're out of the range of thermoelectrics, chiefly because of excessive radiator weight," says Carpenter. "If isotopes instead of reactors are used as a heat source, the electrical power limit is further reduced to two or three kw."

Carpenter reaffirmed that the technology is already in hand to stack thermoelectric units to attain systems with hundreds of watts of electrical power. "They won't be the optimum systems and specific weight would be less than one watt a pound, but they would have the same reliability as solar-cell systems." He observed that such reliability is becoming more important than specific weight, especially for long-duration space flights.

- **Problems**—For thermionics to be competitive with SNAP-50 on an efficiency basis, the emitter surfaces of the thermionic diodes would "introduce a new regime in high-temperature materials for fuels, cladding and insulators for use in long-lived systems," says the AEC. Therefore, "present thermionic work is chiefly in the areas of materials development and irradiation testing of experimental converters and components."

The AEC points out that because of the intimate relationship of the thermionic cell or diode module and the reactor heat source, "the ultimate demonstration of the feasibility of thermionic power systems will require the performance of a thermionic reactor experiment." This means that a fast-flux reactor will have to be developed to try out the diodes instead of the usual lower-temperature thermal reactor used in boiling-water reactor plants. In addition, there are the nucleonics problems posed by fission gas release and fuel swelling at the very high temperatures encountered in thermionic operation.

AEC believes that it will take many years to bring about the successful marriage of a diode to a fast-flux reactor, including development of the needed nuclear technology and materials.

- **Missions**—There are no approved space missions calling for power levels of a SNAP-50 system. Nevertheless, both DOD and NASA express keen interest in attaining such power levels, to the obvious disgust of one of the members of the Joint Committee who called for each of the agencies "to put its money where its mouth is."

Potential missions:

Lunar base power supplies: NASA studies indicate that if lunar explorations should proceed to the point where 12- to 18-man teams are to be kept on the Moon for a year or two, long-lived nuclear-electric powerplants will be needed. The space agency's studies show that the expected average power requirements for such expeditions would be expected to grow from somewhere less than 100 electrical kw to 400 electrical kw (600 kw maximum) and "could best be met by 100- and 300-electrical-kw powerplants."

Lunar cargo vehicle: Further NASA studies show that "electric propulsion associated with a 1,200-electrical-kw SNAP-50 powerplant could offer substantial savings in transporting supplies from Earth orbit to lunar orbit." There are alternates to this application of SNAP-50 (power), "but they involve high costs," says the space agency.

Manned Mars missions: The AEC claims that "electric propulsion combined with a high-thrust nuclear rocket can reduce the initial mass in Earth orbit required for the manned Mars mission by a factor of two from that required for either system by itself."

Other possible missions include military weapons systems, auxiliary power for Earth satellite systems and interplanetary electric-propelled space probes.

There is no doubt that thermionics is developing much faster than published accounts indicate. But even from unclassified works, the outlook is bright. "At the present time, the status of thermionic fuel can be projected for only relatively low power outputs—up to about 50 electrical kw," says Glenn T. Seaborg, AEC chairman. He states that this is no barrier to proceeding with a reactor experiment to establish feasibility of the thermionic concept. ■

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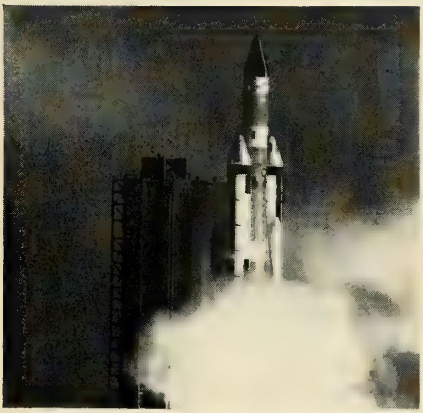

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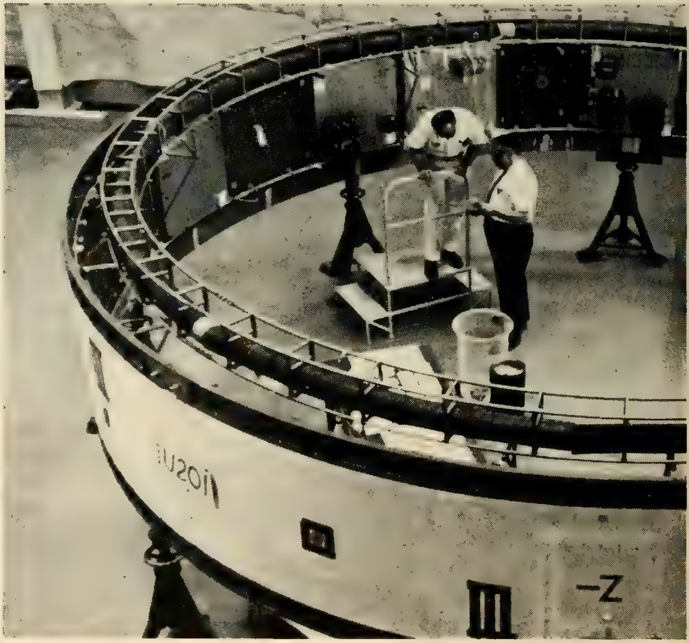

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AF Conducting Further Space Cabin Atmosphere Studies in 68-Day Test

by Heather M. David

SAN ANTONIO—Heretofore unpublished data from decompression tests at the Air Force's School of Aerospace Medicine (SAM) indicate that the incidence of decompression sickness is equal and sometimes more frequent in a simulated spacecraft atmosphere made up of helium/oxygen than one of nitrogen/oxygen.

The Air Force is studying the "bends" problem with an eye to the *Manned Orbiting Laboratory* (*MOL*), which will require astronauts to decompress from a two-gas environment to 100% oxygen spacesuit pressure for extravehicular experiments.

Dr. Thomas H. Allen, chief of SAM's physiology branch, who has conducted decompression profiles with both nitrogen/oxygen and helium/oxygen mixtures, told MISSILES AND ROCKETS that, while a number of tests must still be completed, it appears that bends are as frequent using helium and sometimes even more severe. A number of space physiologists had assumed that the use of helium would minimize bends problems since helium is less soluble in the blood than is nitrogen. However, Allen pointed out that Naval doctors have never made this claim and that their choice of helium was made to avoid the problem of nitrogen narcosis at higher than normal pressures.

The profile now being run by Allen's group at SAM includes 4 hours of prebreathing 100% oxygen at sea level pressure, a switch to 2½ hours breathing with 100% oxygen at 5 psi, as in the *Gemini*, to 4 hours 50/50 oxygen/helium at 7.5 psi, such as in the space laboratory, then to 2½ hours of 100% oxygen at 3.5 psi as in an extravehicular excursion. This latter period includes execution of deep knee bends, push-ups and other simulations of extravehicular exercises by the subject to see if bends result.

Another series of tests will be run with the laboratory simulation portion of the profile at 5 psi oxygen/helium. To complete the spectrum, a possible *MOL* atmosphere of from 70 to 80% oxygen will be tested on the helium/oxygen profile. All the tests are expected to be completed by mid-January so that a recommendation can then be made.

Allen said that further in the future his group will study the use of argon as a diluent gas to give information on the decompression effects from a gas with a high molecular number. With data ranging from helium with a molecular number of four, nitrogen at 28 and argon at 40, he pointed out that it might be possible to extrapolate on the effects of the others in-between.

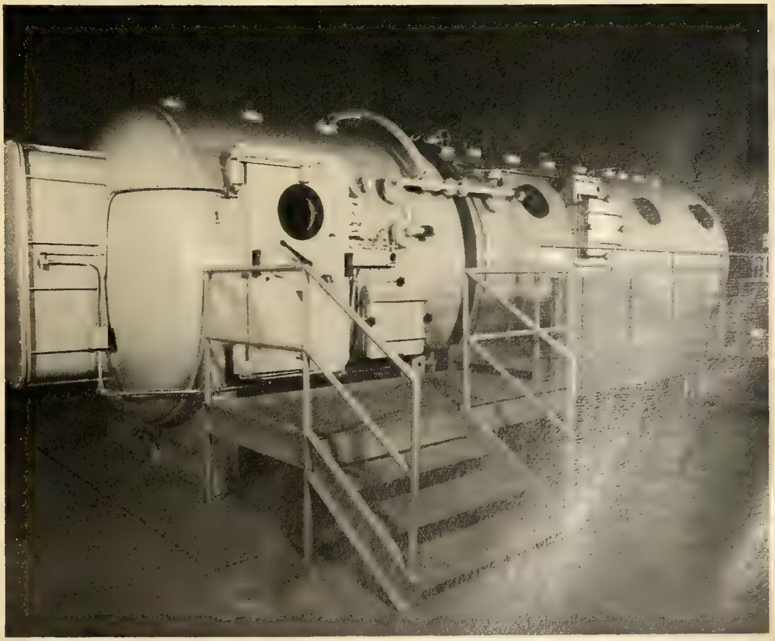
- **Other helium tests**—Elsewhere at SAM, the physiological events of helium at a constant pressure are being studied in what is also the first long-term human exposure to a simulated two-gas spacecraft atmosphere at 5 psi.

According to Gen. Bernard A. Schriever, commander of Air Force Systems Command and head of the *Manned Orbiting Laboratory* (*MOL*) program, the test is in support of the *MOL* program. The 5-psi, 70/30 oxygen/helium atmosphere offers the advantage of having the same total pressure as the *Gemini* capsule, without the problem of the higher partial pressure of oxygen.

- **68-day test**—Four Air Force officers will spend a total of 68 days in the manned space laboratory simulator at the school, with 60 days of this to be spent at altitude. Two other volunteers will spend the time as control subjects outside the chamber.

Purpose of the test, according to Dr. B. E. Welch, environmental systems branch chief at SAM, is to completely validate the gaseous mixture for manned spacecraft use. Any conceivable physio-

FOUR AIR FORCE aircrew members have begun a 68-day stay in this 30-ton chamber at the School of Aviation Medicine. The men are undergoing tests in an atmosphere of 70% oxygen and 30% helium. Results will be applied to MOL and other manned programs.



logical effects should show up during the 2-month exposure, he said.

Previous shorter studies at SAM, with a 50/50 oxygen/helium mixture at 7.5 psi, failed to turn up any physiological anomalies. The SAM experiment at this higher pressure also indicated that speech difficulties that occur with higher percentages of helium—such as those used by the Navy for diving—do not exist to any troublesome extent in the atmosphere ratio being considered for spacecraft.

The much-discussed difference in heat-transfer characteristics with helium did not appear to be as pronounced as was previously theorized either. While it appears that astronauts will need a slightly higher than normal cabin temperature to be comfortable, the difference may not be as great as theory would indicate. There also is indication that the additional helium provides as much as a 50% improvement against fire-hazard.

- **Helium not out**—The communications and thermal comfort phenomena—which at this point appear to be the only drawbacks in using helium as a diluent gas rather than nitrogen—will be carefully studied during the SAM experiment. There has been nothing thus far to indicate that helium should not be utilized, Air Force scientists told M/R.

The scientists are studying the communications problem by having the subjects repeat prepared word lists and participating in other intelligibility tests. The bio-acoustic laboratory at the Aerospace Medical Research Laboratory at Wright-Patterson AFB, Ohio, is giving guidance to SAM officials on this aspect of the test.

The men are being allowed to operate the temperature control of the space cabin atmosphere in order to arrive at their own thermal comfort level. In addition, body and skin temperatures are taken periodically, including measurements immediately after exercise, to determine the rate of heat loss from their bodies.

A great many of the medical tests are the same as those conducted during 100% oxygen, 5-psi runs held several years ago. These turned up a number of minor physiological effects apparently associated with the high oxygen content, which at 5 psi is greater than in the normal sea-level atmosphere.

- **First phase**—The first 8 days or so in the chamber were spent at ground level conditions with a normal atmosphere to get base-line information on the four men. These included measurements of urine electrolytes, steroid catechols, energy balance, hemetological studies, renal functions, baseline exercise information, respiratory functions, lung compartments, body water, plasma volume, body volume measurement, tilt-table and treadmill data, nutritional and bacteriological data.

The men have been trained in taking samples themselves for medical analysis outside the chamber. This includes drawing their own blood and collecting expired gas samples and waste products. They are using clinical equipment for medical measurements with no attempt at simulating space-type bio-instrumentation. The schedule of tasks provides about the same amount of work as would a mission simulation, but there is no attempt at simulating operational experiments. The rest-cycle also includes an 8-hour sleep period.

Cardiovascular studies are aimed at assessing the status of the cardiovascular system, attempting to prevent the effects of deconditioning due to confinement and to determine the thermal load and evaporative water loss during and after exercise periods. Dr. Lawrence Land, cardiovascular specialist at SAM, is conducting pre- and post-experiment physicals.

Routine psychiatric monitoring also is being done, including personality tests, tests of interactions among the crew, and phsyco-motor performance.

Bacteriological samples are being taken from the men's skin and from the atmosphere at intervals. Should any strange results occur in the whole experiment, Welch pointed out, such information might aid in explanation.

- **Food**—The men are eating bite-sized prepared food similar to that in the *Gemini* diet. Food intake acceptability and water intake are being measured. Respiratory studies are putting emphasis on metabolic rate and dynamic response to reduce density.

Other periodic measurements include tests of renal function, liver function and endocrine balance.

The men are also evaluating an edible toothpaste that was developed at SAM's dental department.

Another test involves comparison of beard and nail samples grown at ground-level conditions before the test to those taken at intervals during and immediately after the test. While there is no reason to believe that there will be any difference, it provides another data point, Welch said.

The chamber being used for the test is 30 ft. long and 9 ft. in diameter and is a double-walled compartment to insure purity of the atmosphere. Welch said that while there may be some contamination from nitrogen in the oxygen bottles and through the air lock used, the level is to be kept to less than 0.4%. Trace contaminants will be removed by cryogenic trapping and will be monitored by gas chromatography and infrared spectrometry.

The subjects in the chamber are officers of the Strategic Air Command, including two pilots and two navigators. They were chosen because they fit into the astronaut's age range and for the experience they have had. ■

TEST CANDIDATE, center foreground, takes blood pressure of man on bicycle ergometer. Two of these Strategic Air Command officers are currently being tested inside the chamber and two are being used as control subjects outside.

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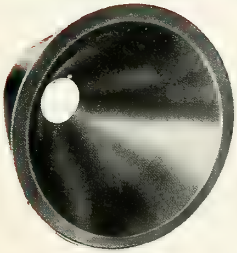

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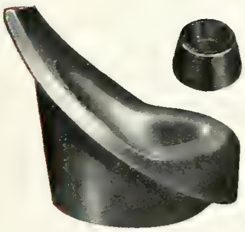

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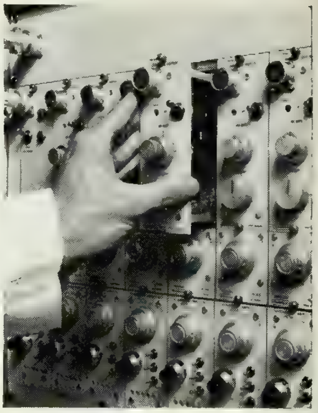

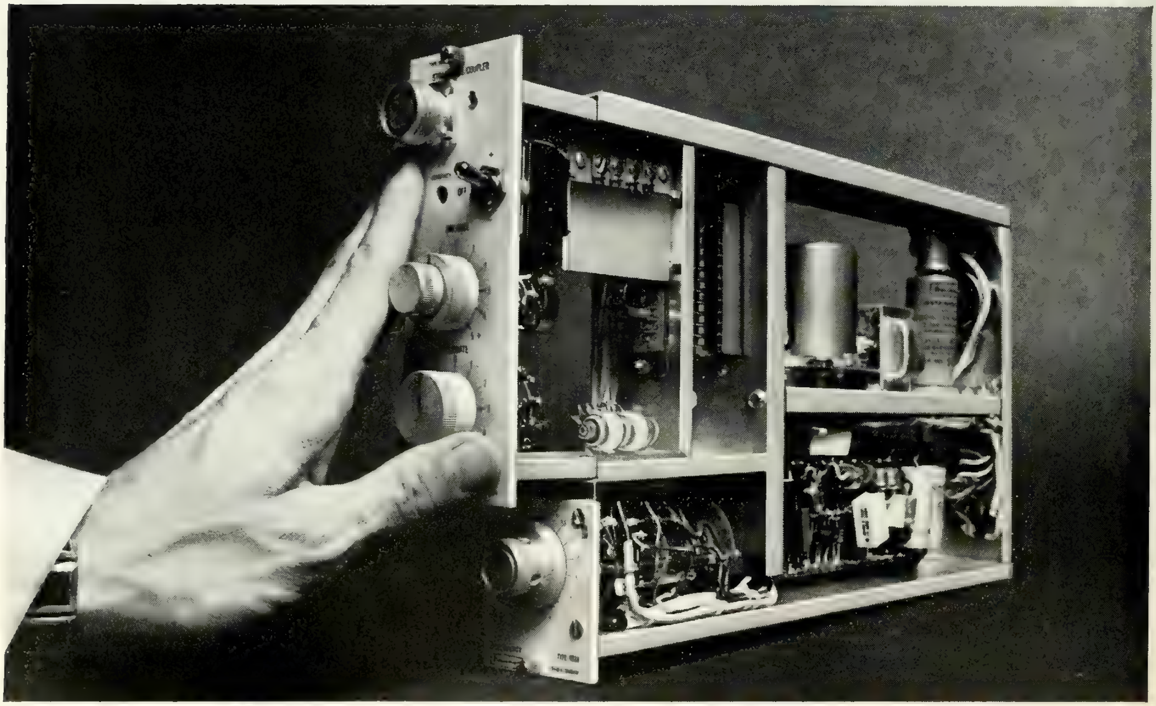

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Agena Ready for New Rendezvous Role

Lockheed official details modifications made to adapt vehicle for upcoming Gemini mission; other uses for system considered

by John F. Judge

THE HIGHLY MODIFIED Air Force *Agena* that is to be used as a target vehicle in a rendezvous attempt with the *Gemini* space craft later this month is now ready for an on-time launch.

The last major test was a wet-mock, launch-simulation exercise in tandem with the *Gemini-Titan* manned system two weeks ago at Cape Kennedy. The *Agena* system worked as designed.

J. Douglas Sailor, manager of NASA Programs Systems Integration at Lockheed Missiles and Space Co., designers of the *Agena,* detailed the entire vehicle system and its systems tests last week at the Manned Space Flight Meeting of the American Institute of Aeronautics and Astronautics in St. Louis.

The *Gemini Agena Target (GAT)* uses the basic *Agena* vehicle, but with a substantial number of structural, command, guidance and propulsion changes. The end result must overcome any significant differences between the orbit parameters of itself and the *Gemini* capsule.

In addition to its primary target mission, NASA is considering other uses for the *GAT* as well as some extensions in the rendezvous modes. No firm decisions have been made as yet, since the demonstrated act of rendezvous is crucial to the entire manned lunar program.

In its maiden flight Oct. 25, the *GAT* will be launched into a 161-n.-mi. circular orbit with an inclination of 28.87° (M/R, Oct. 4, p. 16). The *Gemini* vehicle is then launched to attempt the closing and docking maneuvers.

The Lockheed *Agena* is a production-line vehicle. The basic unit is modified by the user to adapt it to the specific mission requirements. In the case of the *GAT,* NASA's Manned Spacecraft Center in Houston provides the funding and mission requirements.

The *GAT* is based on the Air Force *Agena* vehicle and the program is managed by Space Systems Div., Air Force Systems Command. Lockheed Missiles & Space Co. is the prime contractor.

Sailor detailed every modification. The most minor change is in the electrical power system. Since the *Agena* is basically a battery-powered vehicle, it was only necessary to increase the number of batteries to meet the *GAT* mission requirements.

- **Structural changes**—A forward auxiliary rack 17 in. long with the same 60-in. diameter as the basic *Agena* vehicle provides mounting space for additional batteries and the command and communications system.

This rack mounts on the standard *Agena* interface and is essentially an extension of that surface. The target docking adapter, built by McDonnell Aircraft, mounts directly on this forward rack and consists of a cylindrical section equal in diameter to the *Agena.*

The adapter contains an L-band transponder and an erectable antenna. The transponder is used by the astronauts for tracking and commanding the *GAT* at a range of 250 n. mi. or less.

The docking collar mounted on the adapter is a conical section that serves to correct misalignments and to guide the nose of the *Gemini* until mechanical contact is completed and the latches engaged.

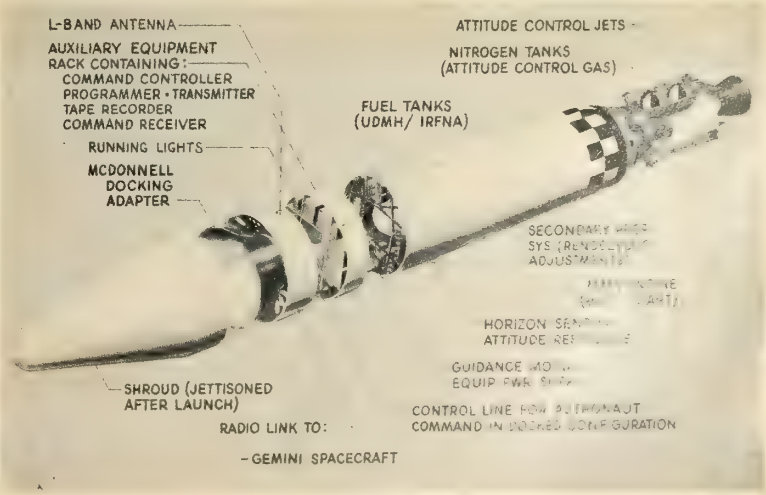
Docking loads are absorbed by three dampers attaching the collar to the adapter. The docking collar is then tightened to permit a rigid mechanical connection between the two vehicles.

A status display panel is mounted directly above the docking collar providing information on the status of the prime and secondary propulsion systems, and the attitude-control system. This panel informs the astronauts of all data necessary to the firing of these propulsion systems.

Flashing acquisition lights and approach lights to illuminate the collar are also mounted on the adapter. A glass fiber clamshell shroud protects the collar during the ascent phase of the flight.

- **Propulsion changes**—The primary propulsion for the *Agena* is the Bell Aerospace Corp. Model 8096 engine. It has a nominal thrust of 16,000 lbs. The fuel is unsymmetrical dimethylhydrazine UDMH and inhibited red fuming nitric acid (IRFNA) is the oxidizer.

LOCKHEED AGENA target vehicle for NASA's Gemini program. Drawing shows modifications required in basic vehicle to adapt it to rendezvous mission.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CONTROL LINE FOR ASTRONAUT COMMAND IN DOCKED CONFIGURATION
SHROUD (JETTISONED AFTER LAUNCH)
RADIO LINK TO:
-GEMINI SPACECRAFT

The engine is normally capable of two restarts in space, but the *Gemini* program necessitated a modification to allow five starts—one for orbit injection, one for inclination change, two for phase changes and one for a post-docking maneuver.

The result is the multi-start Model 8247 engine. This powerplant is basically the Model 8096 engine, with the solid propellant start charges replaced by small liquid propellant start tanks.

These tanks contain flexible metal bellows that pressurize the propellant in the tanks. In starting the engine, valves are opened allowing propellant to flow into the gas generator.

Once the engine bootstraps, the start tanks will refill for the next ignition. Sailor says a potential catastrophic failure mode was uncovered in this area. This would be the instance in which an unloaded turbopump—caused by propellant exhaustion or valve failure—could be driven to a destructive overspeed condition by the propellant in the start cans.

An electronic turbine speed gate was developed to shut down the system before such breakage could occur. A method was developed to prevent heat soak back from the prime propulsion system from causing a bubble in the propellant lines. Such a bubble could enter the containment system in the tanks and destroy its effectiveness.

Motorized propellant-isolation valves were developed to vent the lines after each burn.

Secondary propulsion system modules were developed by Bell for attachment to either side of the aft rack. This system uses components that have flown on previous *Agena* vehicles but are now modularized for ease of attachment or maintenance.

The secondary propulsion system is pressure-fed, using storable, hypergolic propellants. Two modules are used—one on either side of the aft rack. Each module has a capacity of 40,000 lb.-sec.—providing an overlap with the main propulsion system.

Each module has two thrust chambers, one with 16 lbs. thrust and the other rated at 200 lbs. Metal bellows are used for pressurization and ullage control in the secondary propulsion tanks.

- **Attitude control**—The basic *Agena* attitude-control system did not require any significant changes. System versatility had to be extended because it is necessary to achieve both low gas consumption modes and high accuracy modes for the various flight phases of the *GAT*.

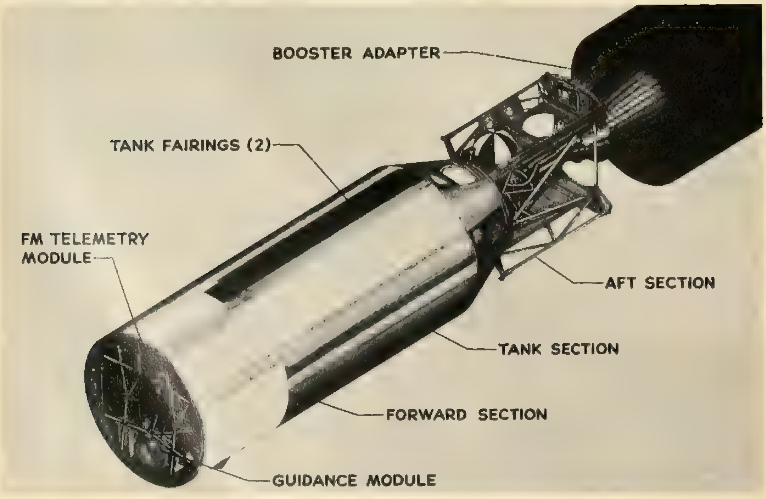
The *Agena* uses two sets of gas jet lines on the aft rack, providing either 0.5 lbs. or 10 lbs. of thrust for coast periods. Engine control in pitch and yaw during the burning period is achieved by gimbal actuators driven by a hydraulic power package powered in turn by high-pressure UDMH from the turbopump. Roll control during engine burning is handled by the gas jets.

The demand for inclination change requires commandable maneuvering ability in the *GAT* as well as an ability to gyrocompass both normal to and in-plane on the orbit. A means of loading the velocity meter in orbit was included and additional gas bottles supplied to meet the 5-day life.

- **Guidance**—Sailor says a flight control logic package had to be developed for the *GAT* to achieve the required versatility for the various attitude-control and propulsion maneuvers involved.

This component allows commands from the programmer to change the interconnections within the basic guidance system to achieve the desired maneuver, attitude-control mode or velocity meter settings.

STANDARD AGENA vehicle, shown in earlier Lockheed artist's drawing, required no significant changes in its basic attitude-control system.



A potential problem that has been obviated is the similarity of the natural frequency of the target docking adapter in the docked mode and the natural frequency of the primary propulsion system's hydraulic control circuit. This would have produced an apparently unstable condition should the astronauts attempt to fire the prime propulsion unit while the *Gemini* is docked to the *GAT*. A filtering network was designed to make the hydraulic circuitry insensitive to oscillations above 1 cps.

- **Command & control**—The *GAT* carries a PCM telemetry system compatable with the control network. This system can transmit 126 channels at one frame per second, plus 113 channels at 16 frames/sec., together with 80 24-bit words at ⅕ frame/sec. and 16 8-bit words at one frame/sec.

A tape recorder is used to store data when the vehicle is out of sight of the ground stations. Two 2-watt transmitters are used—one for real-time data and the other for stored data. These can be reversed on command.

A PCM UHF receiver built by Motorola receives commands from the ground. This receiver, in turn, sends commands to a programmer developed for the *GAT*. After verification of the proper format, real-time commands are sent to an associated controller for execution.

Stored commands are sent to the magnetic core memory unit to await the designated time interval before being transmitted to the controller for execution.

The programmer contains a crystal-controlled electronic clock, accurate to 2 ppm in a 12-hour period. The clock has a resolution of one second.

The memory unit is capable of non-destructive readout for command verification. A number of sub-routines, initiated by a single command, are built into the programmer. The unit has a capability of 93 real-time commands. Any 64 of these can be stored in the memory unit.

There are two tracking units aboard—an S-band transponder and a C-band transponder. Both of these have been used in previous flights.

The heavy, integrated test program at Lockheed uncovered problems in the command and communications subsystems associated with the "clock jump"—time word skipping in the vehicle programmer. This and an occasional loss of telemetry synchronization were solved by designing a new relay box for the programmer and a new power supply box for the umbilical tower. ■

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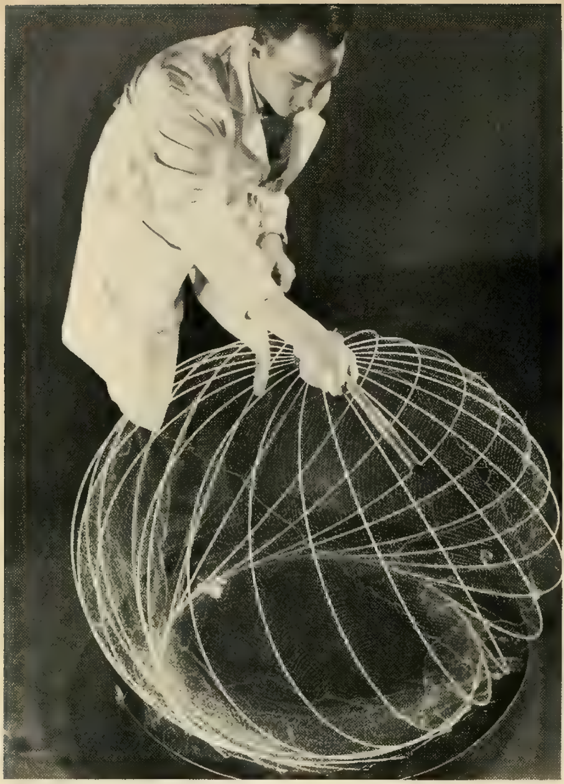

EOS Unveils Unique Passive Reflector

FOLDED AND COILED reinforced glass rods supporting a metallic mesh can be unfurled in space from a 3-ft.-dia. package to a 60-ft.-dia. paraboloidal-reflector antenna. With the addition of a stabilization system, performance of the unique passive communication antenna could compare favorably with that of *Echo II,* the 130-ft.-dia. aluminum/Mylar inflated satellite still in orbit about the Earth.

Developed under a company-funded effort by Lee M. Springer and Detlev E. Hasselman for Electro-Optical Systems, Inc., the collapsible dish provides up to 75% weight savings (and smaller launch volume) over more conventional antennas in use or being considered for space use, the firm claims.

- **Rod frame**—The antenna backing structure is made from highly elastic ¼-in. glass-fiber rods. Developers believe this is the first time such material has been successfully employed in an unfurlable communications reflector array.

The rods are molded from uniaxial filaments in a resin matrix to obtain very high flexibility in the frame. Thus, developers disclosed, with the inherent high strength and low modulus of the rods, the assembled structure can sustain

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These positions are in the Advanced Structural Development group, which has received a number of funded research study contracts which will utilize the most advanced technologies for hypersonic vehicle and rocket engine applications. As builder of the AGENA rocket engine and the LLRV lunar landing research vehicle, now working on the post boost altitude controls for Minuteman II, Bell engineers and scientists are already at the forefront of space-age technologies. More men of this stature are now sought.

Bell's facilities are located just 4 miles from scenic, historic Niagara Falls and the vast Canadian vacationland, yet it's just an hour's flight time from New York or Boston. Educational and cultural pursuits are many; family living and recreational activities excellent.

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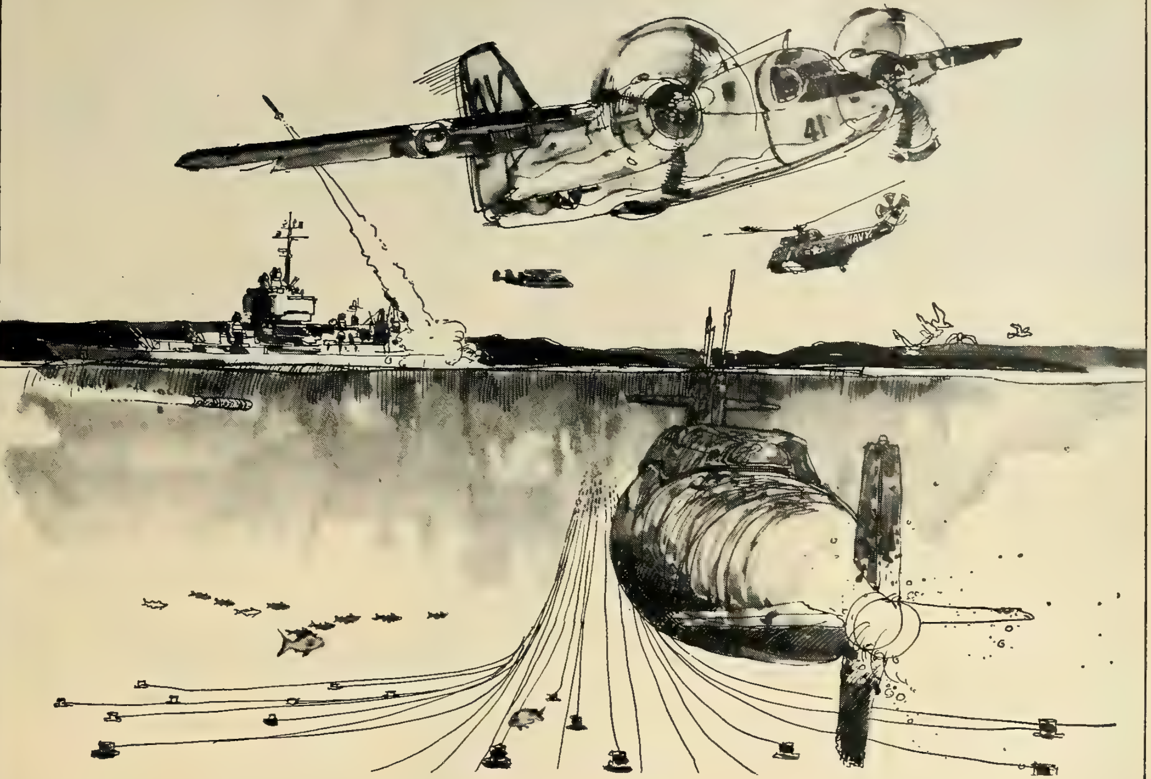

The answers to USW will come from the Tongue of the Ocean.

The Tongue of the Ocean—a large, deep and stable undersea area in the British Bahamas—is the site for AUTEC, the U.S. Navy's new Atlantic Undersea Test and Evaluation Center.

ITT, as prime contractor for AUTEC, is now establishing at the site a unique underwater laboratory measuring some 175 watery square miles. Work has already begun to implement the highly sophisticated electronic systems planned for this vast weapons range facility.

The AUTEC range will be 35 miles long and 5 miles wide, with an impact area 6,000 yards in diameter at its southern end.

AUTEC will permit the whole range of undersea warfare problems—detection, classification, pinpointing and destruction—to be examined in a controlled, yet authentic, environment.

The facility's instrumentation gear, including underwater hydrophone arrays, will enable the Navy to sort out real target information from the rest of its watery environment. This is one of the most complex problems of anti-submarine warfare.

ITT is also prime contractor for Kauai Fleet Tactical Range (KFTR), the Navy's deep-water tracking range off the coast of Kauai Island, Hawaii. This 50-square mile range will provide the Navy's Pacific fleet submarines, surface vessels and aircraft with an instrumented site for conducting tactical exercises.

ITT's broad-range capability for facilities such as AUTEC or KFTR includes equipment for high density storage of multi-channel analog information, recorders for underwater environments, highly sophisticated sonar simulators, signal processing and acoustical hardware, and ocean engineering.

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Present-day deep-running submarines have brought an increased need for an effective method of escape in critical situations. Long concerned with this problem, the survival system branch of the U.S. Naval Applied Science Laboratory joined Hercules engineers in developing an escape capsule capable of withstanding severe pressures during ascent.

Pioneers in development of rocket motor cases made from Spiralloy® filament-wound glass fibers, Hercules utilized the same material in the escape capsule shown here. The material when properly formed provides a structure lighter than aluminum and stronger than steel.

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significant elastic deformation and meet dense packaging requirements demanded in space launch applications.

The radio-frequency reflecting surface is fabricated from a "nair-net" pattern of woven mesh attached at many points to the backing structure. The metallized mesh consists of very thin strands of nylon coated with vacuum-deposited aluminum. Specific weight of the finished mesh is 0.012 lbs./sq. ft. the Xerox Corp. subsidiary says.

- **Space operation**—Following launch and subsequent orbital injection, the big dish framework and reflecting mesh would be automatically unfurled by means of the elastic energy from the tightly compressed glass fiber rods.

To regulate or control the unfurling rods, a torque device is employed as a brake permitting the rods and mesh to slip smoothly from the compressed state.

A tip furling cable, EOS says, is used to allow the assembly to open first into a semi-closed bell configuration. It then slowly expands to a fully opened dish array.

- **Echo II comparison**—By the addition of an automatic stabilization and alignment system for spatial orientation, EOS says transmission range of the antenna would " . . . at least equal present systems such as *Echo II*." With its broad frequency capability—in excess of 1,000 mc—the antenna is on a par with other reflector designs, the company says. A gravity gradient stabilization system could be used with the antenna, EOS declares.

The furled dish, together with a suitable stabilization unit, would weigh less than 100 lbs. at launch. Such a package, EOS stated, would readily fit within a 36-in.-dia. shroud or capsule and could be placed in orbits from 200 to several thousand miles altitude using launch vehicles of the *Thor-Delta* or *Scout* class.

In comparison, the firm pointed out, NASA's *Echo II* inflated passive communications satellite weighs more than 400 lbs. and occupied some 14 cu. ft. at launch. Also, it required a larger launch vehicle, the *Thor-Agena*.

In development for over a year by the firm, research is continuing on the antenna, particularly in the study of other materials for fabrication of the rods and mesh. Instead of aluminized nylon strands, electro-deposited copper is contemplated for the coating. For the backing structure, various metals are being investigated, including beryllium alloy rods.

Existing prototypes have not been tested electrically in the field. However, a 10-ft. model has been mechanically tested repeatedly to study the geometry variations of the paraboloid, a major element in system performance. ■

How to win the revolution in jet air transport...

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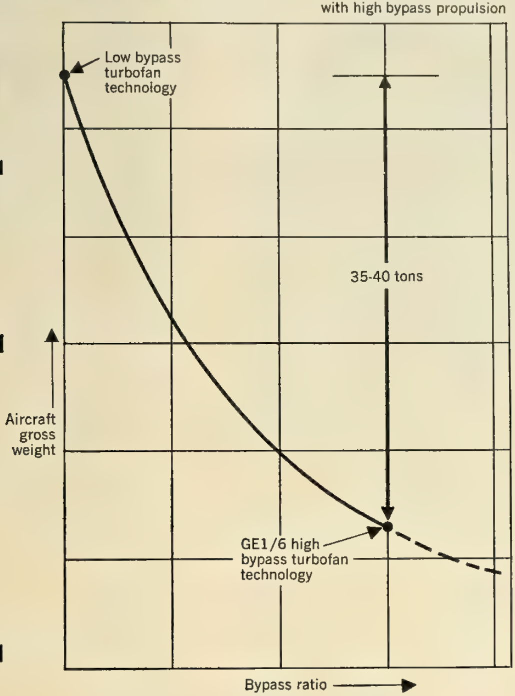

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The military program is scheduled for eight years, and the technical work life is expected to be twice that. Equally intriguing are the potential future derivatives of the GE 1/6, and their implications for radically reducing passenger and cargo costs for large commercial transport aircraft.

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MEC Turning Out TWT's With Increased Power

PALO ALTO, CALIF.—Production of 12½-kw traveling wave tubes with bandwidths extending from 7.7 to 8.4 gc is now in progress at Microwave Electronics Corporation. Production is to be completed by January.

Intended for Army ground transmitter use in communications satellite experiments at Camp Roberts, Calif., the tubes have a minimum efficiency of 35% and rise to 40%.

MEC is building two complete transmitters and their power supplies.

Norman Pond, manager of high-power TWT development at MEC, points out that the new tubes are similar to klystrons in efficiency but have the advantage of increased simplicity from a systems standpoint.

The high power output was achieved, said Pond, by improvements in existing technology. Similar design could produce much higher powers at S-Band.

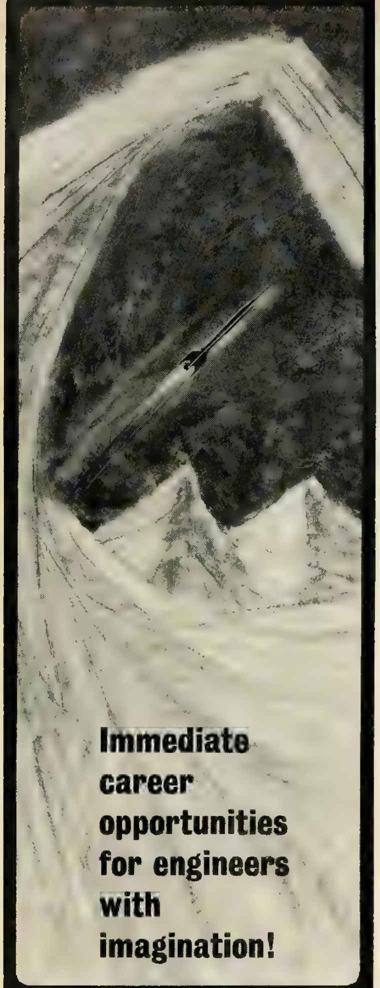
In other MEC work, extension of its present 200-watt high-powered helix-tube series is expected to yield lightweight CW tubes putting out 1 kw at X-Band. These probably will have missile applications.

Also under development is a tube with two outputs. One is a low-noise output, which provides a sensitive receiving element. The second one is a limiter.

MEC has produced variable-gain tubes, with a flat gain characteristic from 40 db to −10 db. Eight of these are used under computer control to feed

Swedish Hybrid Engine in Spectacular Takeoff

SVENSKA FLYGMOTOR'S hybrid rocket engine HR-3F climbs away from its plastic launch support blocks in a recent test flight. Two such tests have been made by the firm at the Swedish testing ground at Karlsborg. HR-3F is driven by hypergolic ignition of fumic nitric acid and a solid fuel grain. The solid fuel, called Tagaform, is a development of Flygmotor's chemical research department. The firm has been commissioned by the Royal Swedish Air Board to carry out research in hybrid propulsion.



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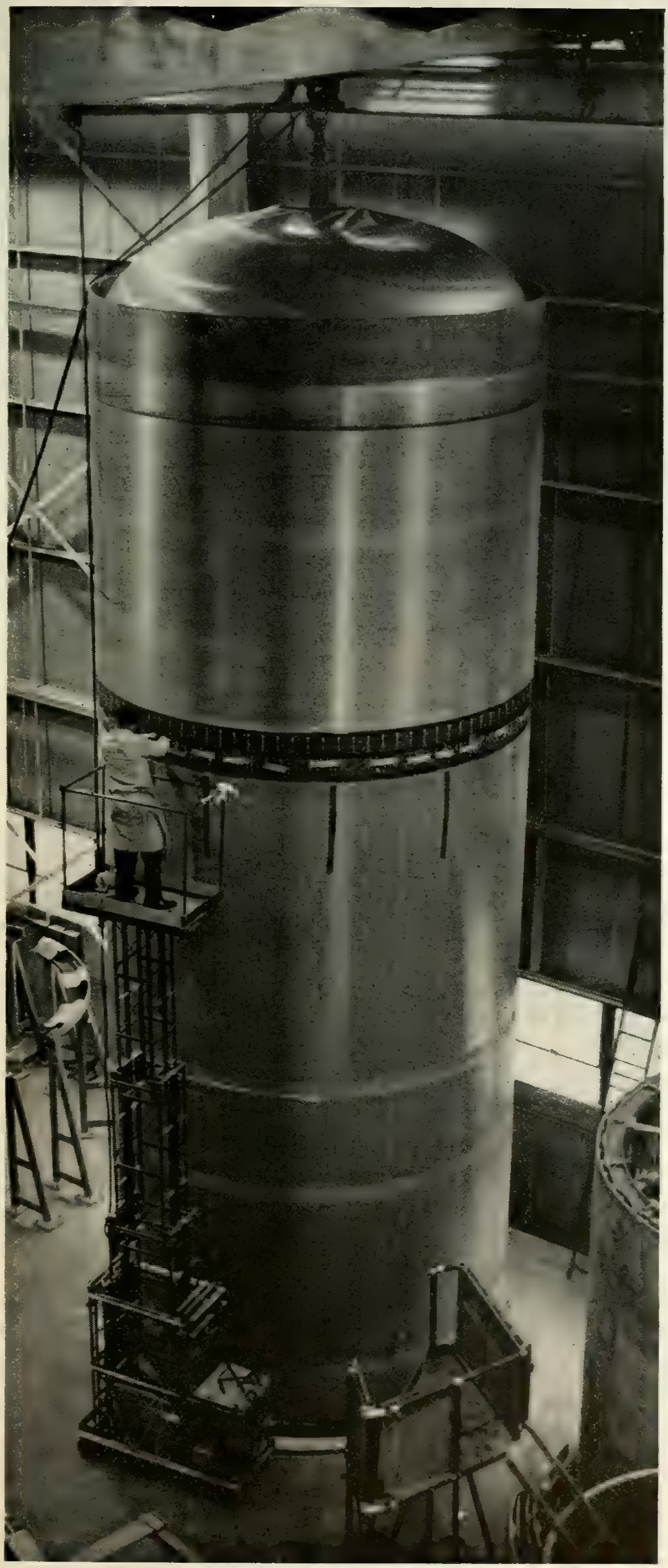

BFG builds largest filament-wound rocket motor case

Before this giant rocket motor case is complete, the two sections shown in the photo will be joined to a third section. The final structure will be 50 feet high, 13 feet in diameter . . . the largest filament-wound motor case yet built.

The sections are made from glass filament and resin wound on a mandrel. The resultant structures offer very high strength with much less weight than metal; have distinct advantages for advanced rocket requirements.

These giant motor cases are being built for special evaluation, on subcontract to Thiokol Chemical Corporation for the U. S. Air Force.

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a phased-array antenna that develops a rotating lobe. Essential in such applications is accurate control of phase as gain is varied.

- **Cutting size**—Director of manufacturing John Wurr noted that the accent on receiver tube development within the company is very much on cutting size and weight. A contract from the Marconi Company, Ltd., of England for 20 backward-wave oscillators is being fulfilled with periodic-permanent-magnet versions that weigh less than 1 lb. These units can operate side by side and do not require heavy shielding. BWO's are being produced for S, C, X, and Ku bands. Typical uses are for electronically tunable local oscillators.

MEC is supplying large quantities of microwave tubes to Electronic Specialty Company for the ARL-20 program. It also hopes to land the production contract for the tubes in the IHAS system, for which its parent company, Teledyne, has the main contract.

- **Solid-state work**—However, a move away from tubes in favor of solid-state microwave devices is seen as a possible future development, and the company has an active solid-state research program.

MEC has a contract from NASA's Goddard Space Flight Center to investigate the feasibility of a solid-state TWT. This makes use of a crystal in which interaction between electron flow and acoustic waves generates gain.

One of the problems is the loss in the transducers that generate the acoustic wave. In an experimental device some 12 db of electronic gain was achieved at 1.75 gc in a cadmium sulphide crystal. But 20-db insertion loss was incurred by the acoustic transducers.

Improved transducers are being developed under another contract. These and improved crystal materials are expected to lead to net gains of 60 db in these devices.

Small solid-state acoustic delay devices are also being developed for use between 200 mc and X-Band. A unit providing two-microsec. delay at L band is being shipped. This has less than 45-db insertion loss. Typical applications are electronic countermeaures and radar calibration.

Delay times can be tailored from tenths of microseconds up to 50 microseconds. Chief problem is suppression of spurious reflections within the solid-state device. Major costs are incurred in the fabrication of the transducers and in the internal matching and contact structure.

Other work at MEC includes development of Gunn effect microwave generators, phonon-photon laser modulators, and electronically tuned variable-delay YIG devices. ■

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New Antenna Seen Most Precise Radio Telescope

THE NATIONAL Radio Astronomy Observatory's new 140-ft.-dia., equatorially mounted paraboloidal-reflector antenna (see cover) may well be the world's most accurate radio telescope.

Dedicated last week (Oct. 13) after 10 years of design and development work by the G. W. Bliss Co. of Canton, Ohio, and the Observatory, the extraordinarily complex structure will be capable of collecting signals from deep space—natural emissions as weak as 1 micro-microwatt. Thus, scientists of the Green Bank, W. Va., observatory point out that the fine directional accuracy of the big dish is paramount for successful and meaningful operation.

Completed in February of this year, the instrument has been exhaustively tested. First real space observations were made in May, when lunar radio source occultation measurements were made by NRAO scientist S. von Hoerner.

Measurements were performed regularly thereafter, and on Sept. 3 a 2-cm wavelength receiver was introduced to provide the first test of the instrument below its design wavelength of 3 cm. Results of that operation showed an aperture efficiency of 40% and a pointing accuracy of better than 10 arc seconds, well within design limits.

- **Ten-year development**—General design of the big antenna was completed in 1956 by N. L. Ashton. Hydrostatic main bearing design was completed the following year by the Franklin Institute in Philadelphia. Bliss completed its fabrication effort in 1961. Despite several false starts in design and construction of the reflector support structure, an all-welded aluminum superstructure was finally selected and built. It includes the largest weldment ever attempted.

A matched pair of 250-ton derricks were required at the Green Bank site to aid in the facility construction.

Shaft and yoke problems dogged the project until 1962, when a redesign was begun by Stone and Webster Engineering Corp. By 1963 the Observatory was able to take over supervision of that task. The drive and control system, built by the Electric Boat Div. of General Dynamics, arrived soon after.

The central hub and polar shaft were built by Westinghouse, the yoke by Sun Shipbuilding and Dry Dock Co.

All components were at the site by late 1964 and the structure was completed early in 1965. The $13-million facility was supported by the National Science Foundation.

- **System design**—Located on a 30-ft.-deep stable concrete pad, resting on bedrock, the base of the antenna includes the control room, all hydraulic and electric equipment, transformer vault, and electronics shop. It is topped by an observation deck nearly 42 ft. above ground level.

The polar axis of the system will rotate through 220 degrees: 110 degrees east of meridian and 110 degrees west. It is defined by a 67-ft.-long steel shaft floated on a 0.005-in.-thick oil film. The polar axis consists of a 40-ton nickel steel tail-bearing casting welded to a 90-ton tubular plate section. The latter is welded to an 85-ton nickel steel conical translation casting which in turn is bolted to a 150-ton spherical nickel steel casting and plate hub. Total shaft weight is 555 tons.

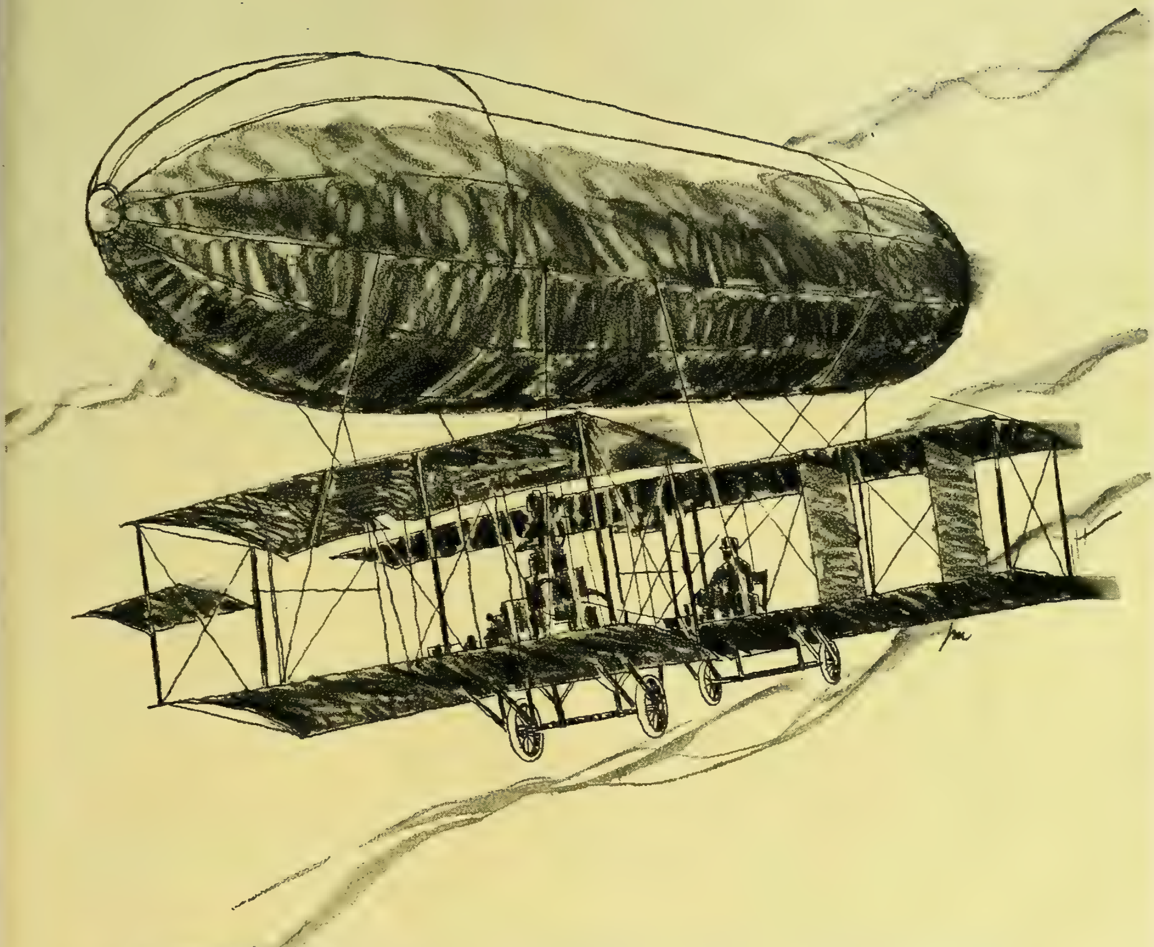
The yoke supports the declination shaft and rotates the antenna east and west about the polar axis.

Constructed of 2 to 6-in.-thick steel plates welded to the main shaft hub section, the yoke carries over 675 tons of concrete to serve as counterweight for east-west rotation.

The yoke is fine-balanced by the addition of 35 tons of portable ballast blocks. It supports two pinion declination drive and three hydraulic stow brakes and is rotated by a steel gear consisting of 28 segments aligned to a total indicator runout of 0.030 in. and a tooth-to-tooth tolerance of 0.003 in.

The length from the polar axis to the declination axis is 49 ft.; pitch radius of the polar gear is 42 ft.

The dish, or reflector, portion of the telescope is a solid-surface parabola



M. César had to compromise to solve his weight problem; pity he didn't have Beryllium

Considering materials available in the 1900's, early aircraft designers showed remarkable ingenuity. In 1911, a Frenchman named César built a combination dirigible-biplane that actually flew—but not very far.

Fifty years later, aerospace designers are still doing battle with the uncompromising forces of gravity. Fortunately, they have more to work with than cloth, bamboo and piano wire. Now they have beryllium. In quantity. In workable form. In many shapes, sizes, structures.

Think, for example, what M. César could have done with beryllium. With its inherent stiffness and high strength-to-weight ratio, beryllium could have answered the problem of how to build in desired strength without adding unnecessary weight—a problem, incidentally, which still faces designers who restrict their thinking to conventional aerospace materials.

Consider what *you* might do with beryllium the next time you're boxed in with a design problem where weight is critical. Better yet, start your design with beryllium in mind—today.

We're too late to help M. César, but we can help you now. Write or call THE BERYLLIUM CORPORATION, Dept. X-10, Box 1462, Reading, Pa. 19603

BERYLCO **Beryllium • Beryllium Copper • Beryllium Nickel • Beryllium Aluminum • Beryllium Oxide**

Circle No. 19 on Subscriber Service Card

Sperry is active in deep submergence

Naturally. Navy's Deep Submergence Program requires in-depth experience in and under the sea. Sperry is a logical choice for navigation and control responsibilities in deep submergence. Sperry has been in the forefront in sea instrumentation and navigation throughout its history. Designer of the first gyrocompass, Sperry today is producing the advanced SINS (Ships Inertial Navigation System) for the new generation of attack submarines and surface vessels. Also, Sperry is navigation Subsystem Manager for both the U.S. and U.K. Polaris programs. Engineering skills here span from the latest microcircuit sonars to specialized computers and displays — and they include the skill for close integration in both equipment and systems. **SPERRY MANAGEMENT GROUP, Sperry Gyroscope Company, Syosset, N. Y.**

SPERRY
DIVISION OF
SPERRY RAND
CORPORATION

Circle No. 20 on Subscriber Service Card

with a 60-ft. focal length. There are 60 aluminum panels forming the surface, each with its own back-up structure attached to the superstructure.

Design surface tolerance of the reflector, without wind and Sun, is 0.030 in. rms in zenith and 0.125 in. rms facing the horizon.

The feed support consists of four aluminum legs and housing which will support 1,000 lbs. of equipment at the paraboloid focus with a maximum deflection of ¼ in. It shades 734 square ft., resulting in 4¾% in reflector surface. The feed stands 200 ft. above the ground at zenith but is only 48 ft. above the ground in the service position, facing the horizon.

The superstructure, which supports the reflector surface and the focal feed and its supporting legs is an aluminum weldment bolted to a horizontal declination shaft on which the telescope rotates north and south.

- **Gears and shaft**—The declination gear, a toothed aluminum half-ring attached to the base of the superstructure, provides the telescope's rotational means. The unit may be rotated 145 degrees north and south of the vertical position.

The declination shaft sits on a counterweighted yoke which rotates east and west on the polar axis shaft. The counterweighting is contained in a steel tube and consists of 675 tons of concrete. This is fine-balanced by an additional 35 tons of portable ballast blocks.

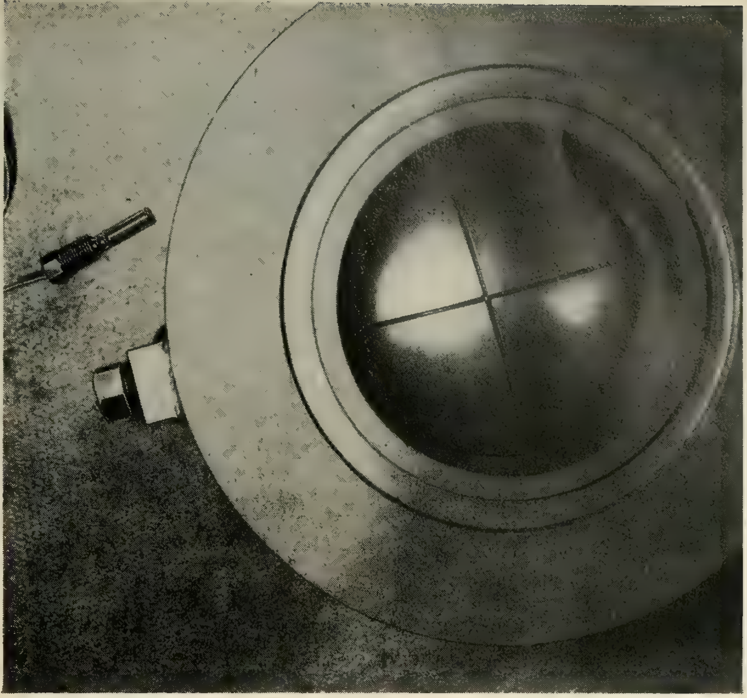
The ring gear extends from the outer edge of the tubular portion of the yoke and permits the telescope to be rotated 110 degrees east and west.

Each of the ring gears is driven by a power train consisting of an electric motor which operates two hydraulic pumps, which, in turn, drive two wobble-plate hydraulic motors through double reduction gears. Each hydraulic motor drives a pinion on the main gear track.

- **Goodyear brakes**—Specially developed industrial brakes, designed by the Aviation Products Division of Goodyear Tire and Rubber Co., grip the two ring gears with such force that the directional variation is less than 0.003 degrees even though the moveable portion of the telescope weighs 2,700 tons.

The six giant brakes—three per ring—together exert more than 1,260,000 lbs. of braking force—enough to assure aiming accuracy in winds up to 16 mph. and to hold the telescope in the aft-stow position in winds up to 140 mph.

The foot-thick declination and polar gears pass between the calipers of the Goodyear brakes. These calipers are mounted in brake-pinion-brake-pinion-brake sequence at the base of each of the half circles. ■



Pat. No. 3,109,553

Quenches a runaway chemical reaction faster than you can wink your eye

The new Fike Deluge Valve uses an explosive charge to actuate and quench an undesirable reaction instantly, completely. It can be detonated manually, by a temperature demand infra-ray sensing and other sensing devices or by a pressure control. Fike can build deluge valves in almost any size for a wide variety of applications—for solid fuel rocket testing; to quench a runaway chemical reaction; to protect a closed pressure system from excessive pressures; for fire control or sprinkler systems; for shock tube applications. A Fike flange assembly holds the pre-scored and explosive charged rupture disc firmly. All electrical system can be case grounded until actual detonation, the valve is safely shipped because the explosive charge cannot be detonated until detonator is attached. The Fike Deluge Valve will handle any liquid or gas quenching medium. The detonator is sealed in the retaining nut and the entire assembly is completely test-proven so that it can be used upstream or downstream on any system. Write for a free brochure.

Fike METAL PRODUCTS
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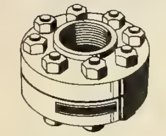
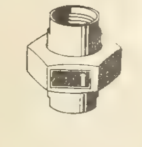
BLUE SPRINGS, MISSOURI

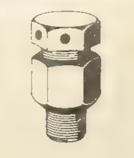
THREE COMPONENT RUPTURE DISCS



RUPTURE DISCS WITH ASA BOLTED FLANGE ASSEMBLY



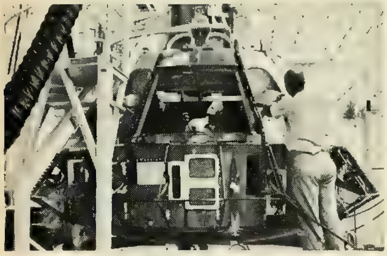
UNION-TYPE RUPTURE UNITS



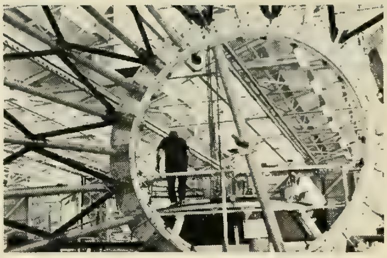
SCREW-TYPE RUPTURE UNITS

Circle No. 18 on Subscriber Service Card

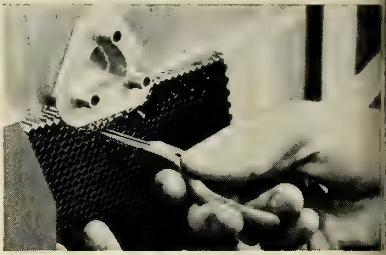
This is how North American Aviation is building the spacecraft that will take three Americans to the moon and return them to earth



The inner shell. At NAA/Space & Information Systems Division, the inner crew compartment of an Apollo command module takes shape. This leak-proof, pressure-tight shell is made of 2014 T6 alloy, 40% stronger and lighter than commonly welded aluminum alloys. To weld this structure, NAA made epic advances in tooling technology.



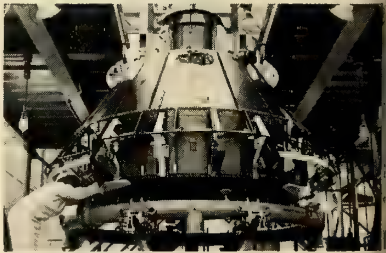
Precision jig. Shaping one Apollo crew compartment requires seventy giant tooling jigs similar to this one. Each jig is built to exact measurements, optically checked. This is why North American Aviation fabricators can hold to tolerances as minute as .010 inch on a space vehicle that stands 14 feet high, with a 13-foot base diameter.



Honeycomb structure. Strips of metallic honeycomb must be cut to exact dimensions and bonded to surface of crew compartment. Over the honeycomb go sheets of aluminum alloy to form a tough, lightweight sandwich panel. Honeycomb technology, using aluminum, was first developed by North American for the F-86.

The outer shell. The other main part of the command module is a heat-proof stainless steel honeycomb shield which fits over crew compartment. The two shells join early in the fabrication process for an exacting compatibility test. This remarkable stainless steel honeycomb technology was first developed by NAA for the XB-70.

Heat shield. Bolted to bottom of inner crew compartment, this shield must bear re-entry temperatures as high as 5,000°F. The outer shell then leaves NAA to be covered with the ablative heat shield. Ablative material is held in a fiberglass honeycomb matrix providing positive attachment method to assure high thermal-structure reliability.



Final assembly. Mating of the two Apollo shells takes place in Building 290 at NAA/S&ID. This is the world's largest clean room—1,500,000 cubic feet of meticulously controlled air space. Here subsystems are installed. And here the completed command module is tested with service module and launch escape system.

The Apollo command module is being built for NASA by North American/Space and Information Systems Division. S&ID is also building the Apollo service module and the S-II stage of the Saturn V moon rocket. North American Rocketdyne is building the rocket engines for all three stages of Saturn V.

North American Aviation

Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Science Center, Space & Information Systems

The Industry Week

Mergers and Acquisitions

Beckman Instruments, Inc., Fullerton, Calif., has reached agreement on terms for acquiring Industrial Instruments, Inc., of Cedar Grove, N.J., a manufacturer of electronic test equipment. The acquisition is to be on a pooling-of-interest basis in exchange for 73,500 shares of Beckman common stock. At current prices, the stock is worth something more than $7.2 million. Industrial Instruments stockholders are scheduled to vote on the proposal Nov. 8. . . . *National Aeronautical Corp., Fort Washington, Pa., has agreed to buy out Air Control, Inc., a Norristown, Pa., maker of environmental equipment for the aerospace, electronics and pharmaceutical industries. National Aeronautical manufactures equipment for removing airborne particles from sensitive work areas.* . . . Amphenol Corp., Broadview, Ill., has purchased Micromega Corp., Venice, Calif. Amphenol has owned 45% of the firm, which specializes in the fields of parametric amplifiers, varactor multipliers, and ferrite devices, for some time. The purchase of the remaining 55% was made for an undisclosed amount. . . . *Electronics Communications, Inc., St. Petersburg, Fla., has given division status to Standard Precision, Inc., Wichita, Kans., formerly a wholly owned subsidiary. Standard Precision makes instruments and electromechanical equipment.*

New Activities

Avantek, Inc., has been formed in Santa Clara, Calif., to develop RF products. Founders and owners of the company are Lawrence R. Thielen, president; Franz C. McVey, vice president for operations; Leonard D. Seader, vice president for engineering; and James E. Sterrett, senior engineer for solid-state developments. All four men are former employees of Applied Technology Inc., of Palo Alto. Initially, products will include solid-state octave and narrow-band RF and IF pre-amplifiers and multicouplers covering VHF, UHF and microwave L band. Future products planned include amplifiers through 2,000 MHz, varactor tuned preselectors through 1,100 MHz and several designed for application in telemetry, radar, communications, navigation, electronic warfare and industrial control systems.

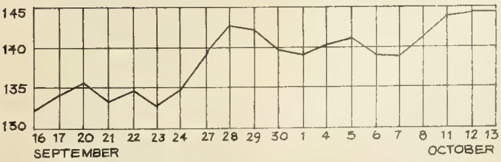
Facility Expansions

Varian Associates, Palo Alto, Calif., plans to build a $3-million facility in Cupertino, Calif., to house its vacuum division. The 150,000-sq.-ft. building is scheduled for completion in late 1967 or early 1968. . . . *Dresser Industries, Dallas, has consolidated its Vacuum Div., Needham Heights, Mass., with its Clark Bros. Div., Olean, N.Y. All Needham operations will be relocated in Olean and Bradford, Pa.* . . . Fairchild Space and Defense Systems Div. has begun construction of a $1-million precision optical facility in the El Segundo (Calif.) Industrial Park. The building will feature a below-grade first floor for vibration isolation and positive thermal control. . . . *Memorex Corp., Santa Clara, Calif., is constructing a 65,000-sq.-ft. building, which will increase the firm's available facilities space by 70%. The building will house research and administrative groups and provide warehouse space that can be used later for production facilities.* . . . Branson Instruments, Inc., producer of ultrasonic products for cleaning, processing and non-destructive testing functions, has moved into a $1.5-million building in Stamford, Conn. . . . *Lockheed-Georgia Co., Atlanta, Ga., last week dedicated its $3.5-million Research Laboratory in Marietta, Ga. The 112,000-sq.-ft. building will house research in such areas as space, aerospace science, physics and chemistry, metallurgy, nucleonics, hypersonic navigation, communications and human factors.*

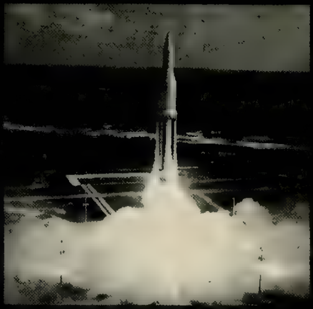
International

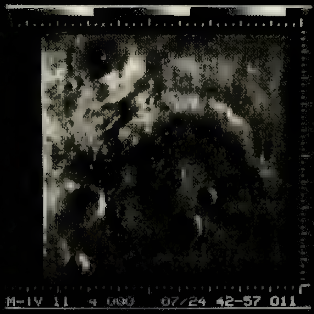
Ferranti Ltd., Hollinwood, Lancaster, England, has been dropped by the Australian government as subcontractor for radar equipment for *Bloodhound* missiles. According to the Australian Minister for Air, the company overcharged on supply of the missiles to Britain and Australia. A refund was made to Britain but not to Australia, he said. Ferranti contended that Australia bought the *Bloodhound* on a fixed-price commercial contract. . . . *Vitro Laboratories, Silver Spring, Md., has opened a field office at Faslane, Scotland. The branch will be associated with the Royal Navy's Polaris school at Faslane and also deal with Vickers Armstrong Ltd., and Cammel-Laird Ltd., two British shipyards presently working on* Polaris *submarines for the United Kingdom.* . . . CTS Corp., Elkhart, Ind., has acquired about 35% of the outstanding common stock of A. B. Metal Products Ltd., Cardiff, Wales, manufacturer of electronic components. The two firms have also completed license agreements covering CTS lines of microelectronic components, carbon composition and variable resistors.

Missile/Space Stock Index



100 = CLOSING PRICES OF 19 REPRESENTATIVE AEROSPACE FIRMS DEC. 31, 1964
STOCK PRICES FURNISHED BY MERRILL LYNCH, PIERCE, FENNER AND SMITH





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what's next, nasa ?

MISSILES AND ROCKETS asked this probing question, "What's Next, NASA?" And on November 29, 1965, MISSILES AND ROCKETS will publish its Fifth Annual NASA Issue with answers to this question as well as an authoritative examination of the National Aeronautics and Space Administration's current and future projects and facilities.

After a year of spectacular achievement, including Astronaut White's record extravehicular space walk and Gemini 5's record 191 hours in space, NASA is looking ahead to its new space programs. Special emphasis is placed in this issue on the Apollo Applications Systems, which have an estimated total cost of over $1 billion, and project Voyager, which will explore Mars, Venus and other planets.

This special issue will also explore NASA's plans for other new projects as the U.S. space program begins its swing away from the exploration of the Moon to the vaster and more challenging mission of probing the planets.

MISSILES AND ROCKETS provides the recognized and authoritative route to reach the men who will be making the research, design, engineering and procurement decisions in these new multibillion-dollar programs.

BONUS CIRCULATION: By request, the fifth annual NASA issue of MISSILES AND ROCKETS will provide 5,000 bonus circulation to the decision-makers in Government, the Atomic Energy Commission, ComSat Corporation and the National Aeronautics and Space Administration.

Publication Date: November 29, 1965 *Closing Date: November 15, 1965*

American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Wash., D.C. 20005

missiles and rockets

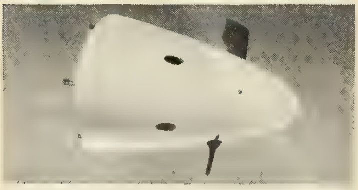
THE WEEKLY OF ADVANCED TECHNOLOGY

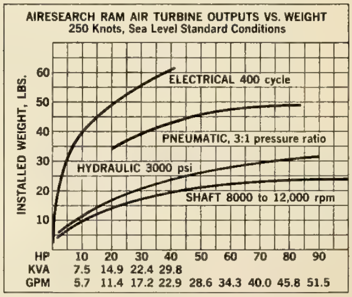
THINK RATS

No ordinary "rats," these.

These are airborne RATS — **Ram Air Turbine Systems** — built by Garrett-AiResearch for emergency or auxiliary electrical, mechanical and hydraulic power.

Maybe you've never considered using Ram Air Turbines as independent power sources. For example, did you know that Garrett-AiResearch RATS can supply electrical, mechanical, pneumatic, or hydraulic power for any externally-stored airborne system such as countermeasure pods, photo or sensor reconnaissance systems, chemical warfare equipment, special armaments such as Gatling-type guns, tow targets, refueling pods, and many others?




AIRESEARCH RAM AIR TURBINE OUTPUTS VS. WEIGHT
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60
50
40
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ELECTRICAL 400 cycle
PNEUMATIC, 3:1 pressure ratio
HYDRAULIC 3000 psi
SHAFT 8000 to 12,000 rpm
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KVA 7.5 14.9 22.4 29.8
GPM 5.7 11.4 17.2 22.9 28.6 34.3 40.0 45.8 51.5

And are you aware that Garrett-AiResearch RATS offer great savings in weight and size over battery-powered systems and hot gas power units?

Garrett-AiResearch has built more than 10,000 RATS for a variety of applications. We offer units from ⅛ to 100 shaft horsepower. Our RATS have better power-to-weight ratios, less drag, instantaneous response, better sensitivity to acceleration and load change, and fine speed control. And they're available now for aircraft, drone and missile applications.

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AIRESEARCH RAM AIR TURBINE SYSTEMS

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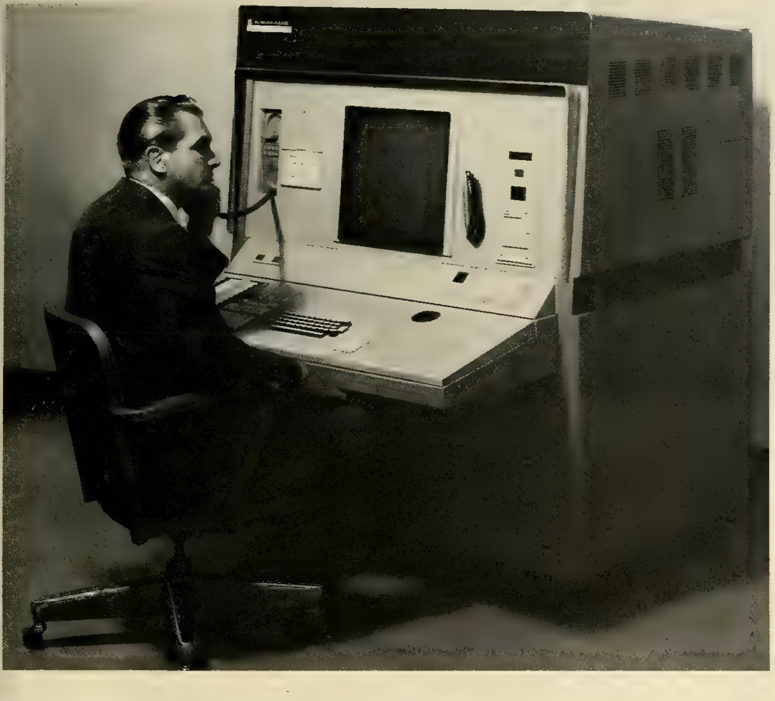


New Product of the Week:

Control/Display Device

A visual analysis console, designed for direct communications with a digital computer in problem-related language, has been developed by Bunker-Ramo Corporation's Defense Systems Division.

The Model BR-90 features a stored program logic and a combined electronic and photographic display on the cathode ray tube. In operation, a basic processor within the console is used to perform all console functions; each control key calls up a sub-routine (or group of sub-routines) which is executed between refresh cycles of the display. The advantage of this approach, the firm says, is the ability to change the display system operation and functions without modifying the hardware.

A CRT permits combining of two types of displays: variable electronic data and fixed-background data. The CRT has an optical window in the rear of the tube; a 70-mm slide projector is used to project the background information through the window, focusing on the phosphor surface of the CRT. Electronic and photographic presentations are fully corrected; overall registration error is less than 1%.

Circle No. 151 on Subscriber Service Card

Temperature Programmer

The TP-200 series temperature programmer, designed for generation of any arbitrary function of temperature without the use of cams or curve followers, is available from Harrel, Inc.

The unit generates the desired temperature function by use of a large number of straight line segments of varying slopes controlled by function dials on the instrument panel. Any function can be programmed in less than 5 min. without the use of external equipment or conversion charts. Standard temperature ranges are available from —75° to 260°C and 40° to 1,100°C, and from —100° to 500°F and 100° to 2,000°F.

Circle No. 152 on Subscriber Service Card

Metal Crystals

High-purity metal crystals in forms suitable for low-energy electron diffraction studies are available from Materials Research Corp.

Using X-ray diffraction attachments and lapping equipment, the company can manufacture crystal slices up to 0.5 in. in diameter by 0.050 in. thick, oriented with specified crystallographic planes to within 0.5 degree of the crystal surface. Surfaces are polished to yield strain-free material.

Circle No. 153 on Subscriber Service Card

Ultrasonic Cleaner

A self-contained ultrasonic cleaning console, the Model E-460, is being marketed by Crest Ultrasonics Corp.

The device provides a band of cleaning frequencies operating in a range of 20-90 kc at the same time. The frequencies create small "scrubbing bubbles" that penetrate tiny crevices, enabling the lower frequencies to rapidly and completely remove all contamination, the firm says. The unit contains a transducerized, ultrasonic cleaning tank, a spray and immersion rinse tank and a forced hot-air drying chamber. It also includes a 1,000-watt generator and stainless steel filtration system.

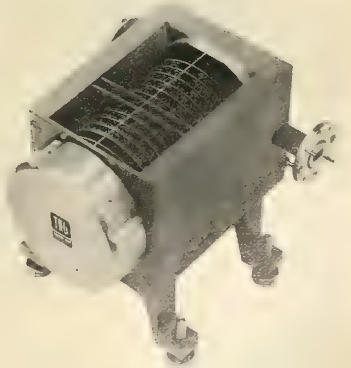
The unit measures 50×27×35 in.; the three tanks each have an 8-gallon capacity. A thermostat controls the air dryer to 250°F at 300 cfm.

Circle No. 154 on Subscriber Service Card

Frequency Meters

A line of direct-reading millimeter-band frequency meters, the Series 551, is being marketed by TRG-Boston.

The unit is available in seven models in standard waveguide sizes covering a range of 12.4 to 110 GHz. Its tellurium copper cavity operates in the TE_{1n} mode; a small hole in the wall of the waveguide couples energy to the cavity and results in a resonance dip in transmitted power of 0.5 to 1.0 db over the waveguide band.



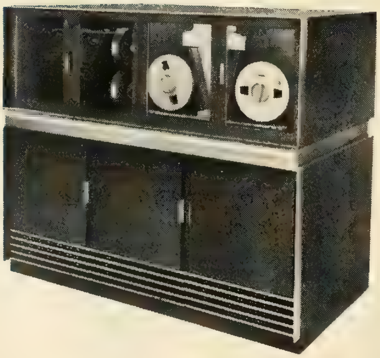
Circle No. 155 on Subscriber Service Card

B-L 120
Microfilm Printer/Plotter

The B-L 120 is the FIRST Second Generation CRT microfilm Printer/Plotter on the Market Today.

The B-L 120 is a truly expandable, modular system, completely **solid-state** and features the latest in high reliability silicon logic circuits.

Truly off line — does not require expensive computer tape transport ● Through-put — 120 frames per minute for both 556 and 800 bpi tapes ● 64 character selection with 128 character option ● Vector line drawing and axes line drawing ● Handles either 16mm or 35mm monocromatic film ● Tape transport compatible with all 7-track, ½-inch magnetic tapes or 9-track, ½-inch magnetic tape ● Optional "Quick-Look" hard copy-exposure simultaneous with film



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Circle No. 22 on Subscriber Service Card

contracts and procurements

AWARDS

AIR FORCE

$3,200,000—**Radio Corp. of America,** Missile & Surface Radar Div., Moorestown, N.J., increase in contract for a classified program.

$2,865,458—**Douglas Aircraft Co.,** Santa Monica, Calif., increment for procurement of *Thor* space boosters. Also $2,257,740 for production of *Genie* rockets for training.

$2,825,374—**General Dynamics,** Electronics Div., Rochester, N.Y., for a further supply of AN/MRC-107 radio communications equipment.

$1,934,360—**Boeing Co.,** Seattle, for continued installation of *Minuteman* missiles near Grand Forks, N.D.

$1,530,200—**Electro-Optical Systems, Inc.,** Pasadena, Calif., for continued development of an ionization thruster for spacecraft.

$1,372,500—**FMC Corp.,** New York City, to make rocket engine fuel.

$1,007,201—**International Telephone and Telegraph, Inc.,** Paramus, N.J., for computer services and programming for the SAC control system.

$750,000—**Radio Corp. of America,** Missile & Surface Radar Div., Moorestown, N.J., for engineering analysis services in connection with BMEWS program.

$250,000—**Polytechnic Institute of Brooklyn,** Brooklyn, for research on hypersonic flows lifting vehicles.

$248,000—**Bunker-Ramo Corp.,** Canoga Park, Calif., addition to original $1.8-million contract for another display console for a computer-driven display system to be used in retrieval and analysis of intelligence information.

$245,000—**Acoustica Associates, Inc.,** Los Angeles, to develop a cryogenic propellant management system for use in space vehicles operating under conditions of varying and zero gravity.

$170,707—**Fairchild Semiconductor,** Mountain View, Calif., to study the dominant failure mechanisms in low-power silicon planar epitaxial transistors.

$86,075—**Texas Instruments, Inc.,** Dallas, for 12-month investigation and study for multicolor laser display model including a technical report.

$75,447—**California Institute of Technology,** Pasadena, Calif., for continuation of research on Air Force Office of Aerospace Research program for research on liquid structures.

$54,000—**Sylvania Electric Products, Inc.,** New York City, from the Rome Air Development Center, Griffiss, N.Y., to improve computer performance by proper selection of the hand-operated devices which feed them information.

$53,732—**Raven Industries,** Sioux Falls, S.D., for high-altitude meterological balloons.

$45,161—**Stanford University,** Stanford, Calif., for continuation of research on basic structures and stability of turbulent shear flows. Also, $49,569 for theoretical studies and investigations of the diffraction of light on laser frequency conversion.

$43,465—**Avco Corp.,** Lycoming Div., Stratford, Conn., for arming and fuzing attitude-control subassemblies applicable to Mk. II re-entry vehicle.

ARMY

$4,178,655—**Hughes Aircraft Co.,** Culver City, Calif., for research on the use by helicopters of *TOW* anti-tank missiles.

$2,771,500—**Emerson Electric Co.,** St. Louis, for armament subsystems for helicopters and inspection and test equipment.

$2,000,000—**General Precision, Inc.,** Little Falls, N.J., for actuation systems for *Pershing* missiles.

$1,608,150—**Cutler-Hammer, Inc.,** Deer Park, N.Y., for test models of special search-and-intercept electronic equipment.

$153,000—**United Nuclear Corp.,** New York, N.Y., for design and construction of gamma irradiation system to provide high-intensity gamma radiation fields from radioactive cobalt and cesium for study of radiation effects on Army weapon systems.

$1,146,650—**Western Electric Co.,** New York City, for operation and maintenance of the *Nike-X* target tracking and discrimination radars at White Sands.

$655,000—**Radio Corp. of America,** Communications Systems Div., Camden, N.J., increase in contract for the AN/PRC-62 program.

$372,420—**TRW Semiconductors,** El Segundo, Calif., for a production engineering measurers transistor contract.

$92,875—**Hodes and Cumming Construction Co.,** Orlando, Fla., for chemical stabilization of the foundation under the mobile service structure rail beams at *Atlas-Centaur* Launch Complex 36-B at Cape Kennedy.

$91,502—**Magna Building Corp.,** Orlando, Fla., for a lightning protection system and mechanical modifications to the Spacecraft Fluid Test Complex on Merritt Island.

NAVY

$2,454,337—**General Electric Co.,** Pittsfield Mass., for operational support studies of *Polaris* missile Mk 34 fire-control systems and Mk 412 test sets.

$1,859,675—**Interstate Electronics Corp.,** Anaheim, Calif., to make *Polaris* test instrumentation equipment.

$1,500,000—**Varo, Inc.,** Garland, Tex., for LAU-7 aircraft missile launchers. Also includes an option to purchase an additional $800,000 worth of units.

$1,146,810—**Sierra Research Co.,** Buffalo, N.Y., for telemetry systems and related equipment for Dash ASW helicopters.

$1,221,400—**General Dynamics Corp.,** San Diego, Calif., for continued research work on ocean-data processing.

$70,000—**Avco RAD,** Wilmington, Mass., renewal contract to examine polycrystalline aluminum and magnesium oxides.

$34,400—**Philco Corp.,** Aeronutronic Div., Newport Beach, Calif., for study of orbiting experiments of classified nature.

NASA

$154,000—**Defense Electronics, Inc.,** Rockville, Md., from Marshall Space Flight Center, Huntsville, Ala., for an industrial utilities monitoring system.

$93,915—**Arthur D. Little, Inc.,** Cambridge, Mass., from Electronics Research Center for study of research selection criteria.

$38,772—**Raytheon Co.,** Equipment Div., Norwood, Mass., from ERC for study of a signal data processor employing a synthetic phase isolatop.

$28,290—**TRW Systems,** Redondo Beach, Calif., from Goddard Space Flight Center for theoretical investigation of the scattering of light by a planetary atmosphere.

Jonker Business Machines, Inc., Federal Systems Div., Washington, D.C., for the installation and continual updating for a one-year period of a Termatrex indexing and searching system, designed to retrieve by rapid visual screening, information on as many as 10,000 personnel.

INDUSTRY

$1,800,000—**Computer Control Co., Inc.,** Framingham, Mass., from **Link Group of General Precision, Inc.,** Tarrytown, N.Y., for four DDP-224 computers.

$1,494,000—**Varian Associates, Bomac Div.,** Beverly, Mass., $879,000 of the total from **WRAMA** (Warner-Robins Air Material, Robins Air Force Base Ga), for magnetrons and microwave packaging devices. The other companies' names not disclosed.

$1,300,000—**International Harvester Co.,** Solar Div., San Diego, Calif., from **North American Space and Information Systems Div.,** Downey, Calif., for fuel feed lines to be used in the second stage of the *Saturn V-Apollo* booster.

$774,000—**Raymond Engineering Lab., Inc.,** Middletown, Conn., from **International Business Machines Corp.,** Space Guidance Center, Owego, N.Y., for design and fabrication of tape memory devices for spacecraft use.

$200,000—**ITT Cannon Electric,** Los Angeles, Calif., from **Sperry Rand Corp.,** Univac Div., New York City, for connectors to be used in airborne computers.

$200,000—**Trans-Sonics, Inc.,** Burlington, Mass., from **Grumman Aircraft Engineering Corp.,** Bethpage, N.Y., to furnish platinum resistance temperature transducers for measurements on the Lunar Excursion Module vehicle.

$26,031—**Conic Corp.,** San Diego, Calif., from **Gyro Co.** of America, St. James, N.Y., for design and fabrication of test sets for Conic telemetry transmitters.

$57,000—**Radio Corp. of America,** Astro-Electronics Div., Hightstown, N.J., from Princeton University, Princetown, N.J., for the evaluation of performance of an image integration system for Stratoscope project.

PROCUREMENTS

REQUESTS FOR BIDS

U.S. Naval Ordnance Test Station
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Pasadena, Calif. 91107

Necessary services and materials to conduct tests and perform a study to analyze problem areas in *Shrike* antenna structure. Only firms determined to be sufficiently experienced or qualified in an area similar to that involved will be furnished RFP.

United States Army Materiel Command
Harry Diamond Laboratories
Washington, D.C. 20438

Negotiations will be conducted on a sole-source basis with Lockheed Missiles & Space Co., Palo Alto, Calif., for a study of cross sections and effective collision frequencies in *Mercury*. For information only; RFP not available.

Office of Naval Research
Washington, D.C. 20360

Negotiations are to be conducted with Airtron, a division of Litton Industries, Mossis Plains, N.J., for further research on an attempt to grow large single laser crystals by the hydrothermal methods under contract Nonr-4616(00). For information only; RFP not available.

Office of Naval Research
Washington, D.C. 20360

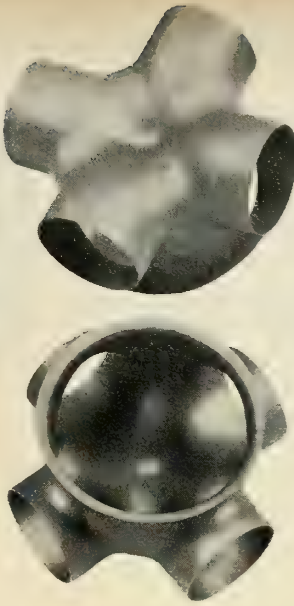
Office of Naval Research has received an unsolicited proposal from Rocket Research Corp., Seattle, for the analysis and preliminary testing of a subliming solid microthruster and is considering the award of a contract to Rocket Research Corp.

Directorate of Procurement
Air Proving Ground Center
Eglin Air Force Base, Fla. 32542

Contractural effort is contemplated with Lockheed-California Co., Burbank, Calif., for the evaluation of surface-to-air missiles in a tactical environment. For information only; RFP not available.

Contracting Officer
National Aeronautics and Space Administration
Langley Station,
Hampton, Va.

Negotiations with Douglas Aircraft Co., Inc., Missile & Space Systems Div., Santa Monica, Calif., for a study of design requirements for reactor power systems for manned Earth orbital applications. For information only; RFP not available.



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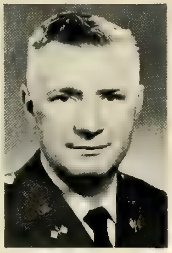
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William H. Moore: Elected a director of Fairchild Hiller Corp. He is chairman of the board of Bankers Trust Co., New York.

David L. Evans: Joined Atlantic Research Corp. as executive assistant to the chairman of the board and chief executive officer of the company. Evans is a retired Air Force colonel whose most recent assignment was with the State Department.

Col. Mitchel Goldenthal: Appointed to the command of the U.S. Army Satellite Communications (SATCOM) Agency in Fort Monmouth, N.J. He was also appointed Acting Project Manager SATCOM.

Richard P. Prybyl: Appointed manager of *Minuteman* Electronics Projects at the central operation of Sylvania Electronic Systems. He is responsible for design improvements in the radio launch control system for the *Minuteman* intercontinental ballistic missile and design, development and production of associated operational and maintenance equipment.

Dr. Daniel E. Noble: Elected vice chairman of the board of Motorola, Inc., and designated the corporation's chief technical officer. He will continue as group executive with direct authority over four of the company's six operating divisions.

Louis D. Delalio: Appointed president of Filtors, Inc., which manufactures high-reliability relays for military and space applications.

Robert G. Loewy: Named chief scientist of the United States Air Force. He is an associate professor of mechanical and aerospace sciences at the University of Rochester. It is a 1-year appointment.

Irv Ross: Appointed vice president and general sales manager of Avtel Corp. He will direct a national marketing and sales effort in the field of precision inverter-converter power sources and polyphase frequency changers for the aerospace industry.

Ralph D. Paine, Jr.: Elected a member of the board of directors of Itek Corp. Itek specializes in information technology.

Dr. George H. Brown: Elected to the board of directors of the Radio Corp. of America. He is RCA executive vice president, research and engineering. **Robert E. Kintner,** also elected to the board, will be chairman and chief executive officer of National Broadcasting Co.

Richard F. Wehrlin: Named vice president & manager of European operations, of Servo Corp. of America, an electronics firm and infrared equipment developer.

Dr. John A. Sanderson: Chosen president-elect of the Optical Society of America. He is acting associate director of research of the U.S. Naval Research Lab, in Washington, D.C.

David R. Hull: Appointed a member of the eight-man Joint Technical Advisory Committee, sponsored by the Institute of Electrical and Electronics Engineers, Inc. Mr. Hull is the new director of the EIA Engineering Dept.

Robert W. Sproul: Joined Adams-Russell Co., Inc., as director of advanced development. He will direct activities of advanced development groups working on long-range development of passive and active devices and techniques.

Arthur J. Wilde: Moved to a new post in Motorola, Inc.'s, marketing division headquarters in Washington, D.C. He was midwest regional manager and manager of Air Force Programs of the Motorola Military Electronics Div. office in Dayton, Ohio. **Ben J. Thompson** will succeed him as manager of the Dayton office.

Richmond A. Lewis: Named Raytheon Computer eastern regional manager for modules and equipment. He was formerly senior eastern regional applications engineer.

James S. Locke: Named vice president and general manager of Honeywell's Micro Switch Div. in Freeport, Ill. **Clyde A. Parton** has been appointed vice president in charge of Honeywell's industrial products group, which includes the Philadelphia division, Denver division and Minneapolis-based Apparatus Controls Div. **Edward C. Vorlander** will succeed Parton as head of temperature controls.

Arthur R. Kantrowitz: Named chairman of American Institute of Aeronautics and Astronautics 3rd annual meeting. He is a director at Avco-Everett Research Lab. **Peter Rose** is deputy general chairman of the meeting.

Hugh Van Cleve: Appointed general manager of Pacific Optical Corp. Mr. Van Cleve will be responsible for all of the division's operations, including marketing, design, fabrication, and testing and inspection of precision optical systems.

William Grell: Appointed special products coordinator for the Connector Div. of Methode Electronics, Inc. He will be responsible for handling all inquiries pertaining to special connectors and assemblies and coordinating engineering, manufacturing and production on the scheduling and entering of customer orders.

James J. Catrambone: Appointed director of financial analysis for Columbia Broadcasting Co. He will be responsible for budgets, planning and analysis, and systems and procedure activities.

J. David Haun: Joined the field sales staff of Fairchild Semiconductor in the Palo Alto, Calif., office.

Col. William R. Large, Jr.: Named assistant for staff support in Aeronautical Systems Div., Wright-Patterson AFB, Ohio. He was previously Commander at Headquarters, eastern contract management region, Olmsted AFB, Pa.

Edward A. Troost: Appointed comptroller of the ITT Semiconductor division. He formerly served as manager of Cost-Price Analysis on ITT headquarters staff.

Arne L. Berg: Appointed chief engineer of Concertone, a division of Astro-Science Corp. Berg is responsible for the research, design, and development of Concertone's new audio consumer products.

Frank Elliot: Appointed assistant plant manager of the Malden piston plant of the Sterling Div., Federal-Mogul Corp. He had been with the company's National Seal Div.

Rick Green: Appointed sales manager for Electronic Memories, Inc. He will be responsible for marketing all the firm's memory products.

—when and where—

Electronic Packaging Conference, sponsored by the Society of Automotive Engineers, Inc., International Hotel, Los Angeles, Oct. 20-21.

1965 International Electron Devices Meeting, sponsored by the Institute of Electrical and Electronics Engineers, Sheraton-Park Hotel, Washington, D.C., Oct. 20-22.

1965 Annual Meeting of the National Aeronautic Association, Mayflower Hotel, Washington, D.C., Oct. 21-23.

Photography in Information Storage and Retrieval, sponsored by the Society of Photographic Scientists and Engineers and the Army Research Office, Marriott Twin Bridges Motor Hotel, Washington, D.C., Oct. 21-23.

21st Anniversary National Electronics Conference and Exhibition, McCormick Place, Chicago, Oct. 25-27.

Third Annual Conference on Energy Conversion and Storage, sponsored by Oklahoma State University School of Electrical Engineering, Stillwater, Oct. 28-29.

Seminar on "Determination of Physical Properties of Materials Through Sonic Resonant Methods," sponsored by Magnaflux Corp., Battelle Memorial Institute, Columbus Laboratories, Columbus, Ohio, Nov. 3-4.

1965 Space Fair, sponsored by the Navy, Pacific Missile Range Headquarters, Point Mugu, Calif., Nov. 6-7.

1965 Winter Annual Meeting of the American Society of Mechanical Engineers, Chicago, Nov. 7-12.

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Hardly a Time for Complacency

RAPID PROGRESS in the U.S. space program has led many not knowledgeable in the field to conclude that the U.S. has overtaken and passed the Soviet Union in space technology.

This is a dangerous and false assumption.

It is true that in the past five years this nation has extended its technical proficiency in space at a remarkable rate. The accomplishments on the record are dramatic evidence of this.

The National Aeronautics and Space Administration has achieved a high level of competence in a complex field in a very short time. Its record in manned spaceflight in the *Mercury* and *Gemini* programs is one of which the entire nation can be proud. NASA may very well chalk up five manned flights in the *Gemini* program this year, demonstrating along the way orbital rendezvous, extravehicular activity and extended stay-time in orbit.

At the same time, NASA's accomplishments in the field of unmanned scientific exploration, from the *Ranger* and *Mariner* of Jet Propulsion Laboratory through scores of orbital satellites and atmospheric probes, are impressive and unequalled by the Soviet Union. There has been no comparable period in the entire history of science when so much knowledge has been acquired about the universe in which we live. In addition, we are making ever more extensive and practical use of space for communications, navigation, weather forecasting and reconnaissance.

One result has been an increased Soviet willingness to exchange scientific data gained in space with the U.S. Just last week, it was revealed that the Russians have agreed to a further accord in this direction.

But even in the face of such an impressive record of manned and unmanned space achievement by NASA, it is incorrect to state that the U.S. now has surpassed the Soviet Union in space technology.

For one thing, the relative emphasis in the space programs of the two nations must be understood. From the beginning, the Russians have undertaken a careful step-by-step program of space exploration leading directly to manned spaceflight. One need only recall how quickly the Soviets put the dog Laika into orbit to realize their immediate interest in the question of whether man could survive in the hostile environment of space. Soviet achievements in the unmanned scientific field have been desultory because their budget has been directed almost entirely at manned accomplishment.

And even the Soviets have their budget problems in the unmanned scientific programs. Academician Leonid Sedov made it clear in Athens last month that he is quite accustomed to defending the Russian scientific program when he told us:

"I am often asked whether it pays to spend so much for cosmic investigation. Cosmic research work provides the basis for human knowledge in general. It is widely known that the most vital work of the greatest practical value is the research at the boundaries of human knowledge."

The Russians also made it evident at the International Astronautical Congress in Athens that they are continuing their hard-paced, step-by-step drive toward a manned lunar landing. If present indications are correct, however, their emphasis is on Earth-orbital rather than lunar-orbital rendezvous.

Cosmonaut Alexei Leonov told a plenary session: "It seems to me that the time is close at hand when multi-man scientific research space labs manned by periodically rotated crews will appear in orbits around the Earth, to be followed by permanent space stations and manned landings on the Moon and the other planets of the solar system."

ALL OF THOSE WHO FELL for the malarkey some time back about Soviet cancellation of the manned lunar program would do well to ponder Leonov's statement.

Questioned later at a press conference about his reference to space stations supplied by space ferries, Leonov said: "I cannot now say precisely the date and year, but I can say that the weight of *Proton I* is greater than 12.2 tons. It is quite enough to carry half of this audience (of about 100 persons)."

The Soviets are not noted for making casual remarks about their space program. It will be remembered, for instance, that they signalled the launch of *Sputnik I* well in advance. Therefore, the remarks of Leonov can be considered significant.

So can those of Sedov when asked about the Russian lunar landing project: "The Soviet Union has a program of cosmic research. Moon research is part of this program. The problem of soft-landing on the Moon is a subject of discussion and research in the Soviet Union. Such a landing on the Earth's surface is already developed in *Voskhod*. For instance, the cosmonauts have landed in the capsule using soft-landing devices. As to a Moon landing, we must say this problem is connected with further research—it has many problems. . . . That's why I am not able to just name a precise date for such a venture—we just don't have one. I would like to mention that in the Soviet program, each step is connected with an achievement that is vitally needed for the next step. Such steps are possible on the road to the Moon."

There certainly should no longer be any doubt in anyone's mind about the existence of the Soviet counterpart of the U.S. *Apollo* program. Add to this the acknowledged existence of an operational Soviet booster considerably more powerful than any the U.S. yet has available. Add to this the fact that the Soviets already have flown three-man spacecraft. Add to this the capabilities of the heavy *Proton* craft. Any claim for a U.S. pre-eminence in space then appears quite ridiculous and soon may be made more so by Soviet accomplishments.

William J. Coughlin

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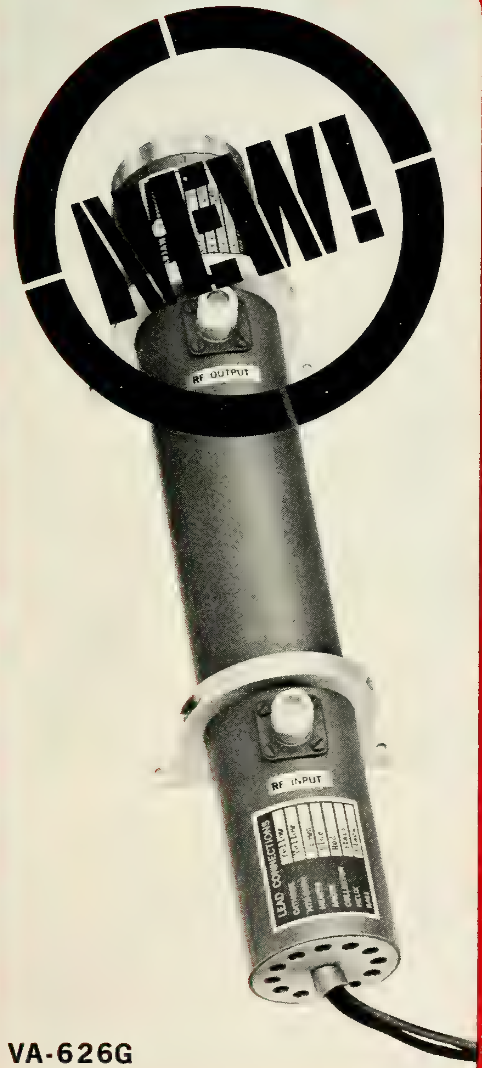

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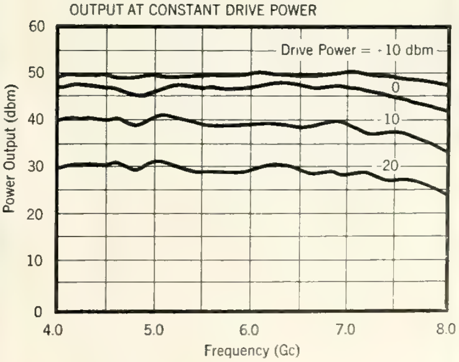

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The Cape Kennedy-Houston GLDS is part of a 225,000-mile global tracking and communications network used by NASA to control space missions. It is another example of the vital role communications play in the progress of space exploration.

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missiles and rockets
THE WEEKLY OF ADVANCED TECHNOLOGY

Volume 17, Number 17 October 25, 1965

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THE COVER

Air Force Titan III-C rises from Cape Kennedy in second launch of the system. Late last week, mystery still surrounded failure of the vehicle's Transtage. Data indicated a catastrophic Transtage failure, and apparent destruction of the two satellites aboard. See p. 10.

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letters

Smoke Screen Protection

To the Editor:

I am writing with respect to Harry Bricker Fuchs's letter in M/R, Oct. 18. Mr. Fuchs's claim of protection by smoke from nuclear weapons explosions is backed by the standard reference in this field, "The Effects of Nuclear Weapons," U.S. Government Priting Office, Washington, D.C. 20402.

The February, 1964, edition of the above reference states in paragraph 7.19 that "Artificial smoke can behave like fog in attenuating thermal radiation. A smoke screen between the point of burst and a given target can reduce the thermal radiation to an extent dependent upon the density and thickness of the screen. Smoke screens, especially those which contain particles that absorb and do not merely scatter the radiation, thus appear to provide the possibility of protection against thermal radiation from a nuclear explosion."

The 1962 edition of the same reference states much the same in its paragraph 7.19; however, it states that "a dense smoke screen between the point of burst and a given target can reduce the thermal radiation energy to as little as one-tenth of the amount which would otherwise be received at the target."

It may be seen from the above that the possibility of protection by smoke from nuclear weapons explosions is worthy of serious investigation.

A free price list, PL 84 *Atomic Energy and Civil Defense,* describing "The Effects of Nuclear Weapons," and related publications may be obtained from the Government Printing Office at the above address.

David W. Johnston
Washington, D.C.

Putting Down the Foot

To the Editor:

I have observed with interest letters in recent months debating and struggling over the problems created for your publication and others by the multiplicity of abbreviations and symbols that must necessarily be used in the missile/space literature.

Obviously, this problem is likely to get worse before (if ever) it gets better. The almost incredible number of "shorthand" terms that one must somehow try to keep in mind—each area of technology having its specialized collection—can be expected to increase almost from week to week, as new units of measurement are adopted and new terms created (sometimes unnecessarily, merely to honor some pioneer in a given field).

Each of us has his own ideas as to what abbreviation or symbol is appropriate in a particular usage. There are, of course, some official source-lists, national and international, that attempt to keep our practices consistent. But these can never be comprehensive enough or current enough to really solve the problem.

I won't get involved here in any specific arguments as to the relative merits of big and little "K's" or "G's"—or p's and q's.

But I do have one potent suggestion. Why not cut the problem in half—by at long last joining the rest of the civilized world and adopting the metric system?

(Even the nation that originated the "English System" has announced that it is going to abandon it. When that happens, we'll be all by ourselves with our pounds, inches, fps and psi.)

Not that things wouldn't still be complicated enough to keep us all frantic. But at least the burden would be very substantially reduced.

A. W. Jones
(Anglo Saxon)
Seattle

Oceanology Report

To the Editor:

Please accept my compliments on the excellent Special Report on Oceanology in the Sept. 6 issue of MISSILES AND ROCKETS.

Especially informative and useful is the section devoted to submersibles—probably the most complete and up-to-date report possible to assemble in a field so fast-moving.

Your thoughtful articles indicating the probable trends in oceanology—both in the technology and the market—should also be widely appreciated. Again a remarkable job, in view of the nature of the beast.

Last but not least, the visual presentation was quite superior. The cover photo is beautiful, and the layout in general matches the standard set by the entire report.

I hope that all this means we can look for much more of the same in forthcoming isues—and perhaps to another special report on oceanology in the not-too-distant future.

You are most certainly on the right track in expanding your coverage to include in-depth reporting on the new frontier of the oceans.

John Cummins
Chicago

REPRINTS

A 36-page reprint of the MISSILES AND ROCKETS *special report on oceanology, which appeared in the Sept. 6 issue, may now be obtained from:*

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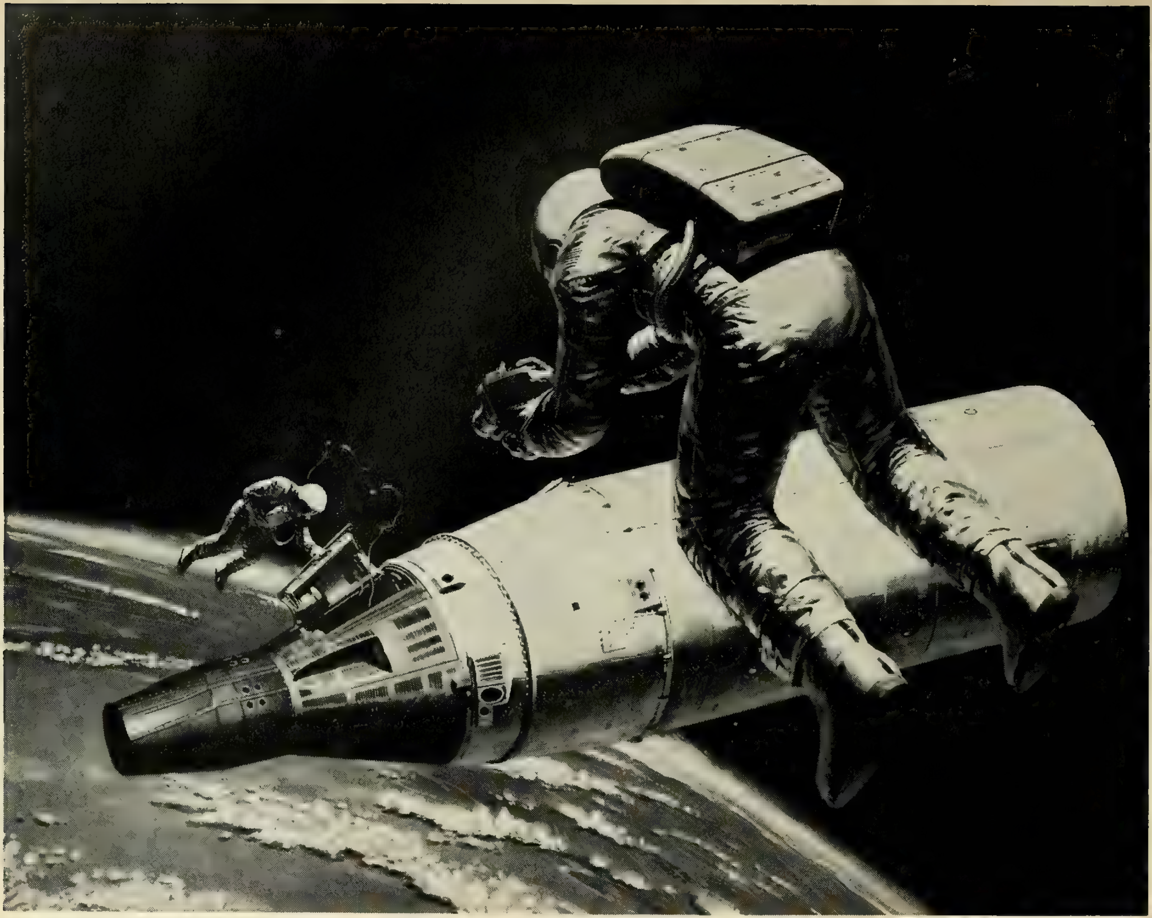

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The Countdown

WASHINGTON

Nike-X Announcement Is Expected

Pentagon insiders tell COUNTDOWN a major announcement on future of the *Nike-X* anti-missile missile project may be forthcoming within the next few weeks—probably from the White House. Top Dept. of Defense officials state flatly that the cost of the war in Viet-Nam will affect neither the nature nor the timing of a budget decision on *Nike-X*. All of which sounds like good news for the program.

Sea Sparrow Ships to be Increased

Navy sources report that additional ships will be designated in the near future as test vessels for the *Sea Sparrow* point defense system now under development. The shipboard version of the already-developed *Sparrow III* air-to-air missile was installed initially aboard a Navy LST last Spring. Original concept called for installation of *Sea Sparrow* only aboard basically undefended vessels. Now, Navy planners say they hope to increase air-defense capabilities of all ships with the weapon, possible replacing 3- and 5-in. anti-aircraft guns. Decision on *Sea Sparrow* production still is 1½-2 years off, according to the Navy.

GTA-8 May Go Early in '66

Unconfirmed reports that the *Gemini-Titan-Agena 8* mission may fly early next year are somewhat substantiated by delivery plans for the spacecraft and launch vehicle. A Manned Spacecraft Center spokesman confirms that McDonnell will have the spacecraft at Cape Kennedy in mid-December. Delivery of the *Titan II* launch vehicle, now in a test cell at Martin-Baltimore, is expected by the end of the year. *GTA-8*, a rendezvous and docking mission, will include extravehicular activity (EVA) lasting one full orbit.

Hughes Expected to Get SAM-D Contract

Army Missile Command is expected to follow up its recent $1.8-million award to RCA for continued component research and development on the *SAM-D* missile system with a similar contract to Hughes Aircraft. Both firms have competitive contracts on the program. Announcement of the Hughes follow-on award is expected this week. Army project sources are hopeful that a decision to move the new field air/missile defense weapon into the contract definition phase is not far off. Both firms will get such contracts if a go-ahead is given.

Joint Missile Study Is Completed

Joint Army/Navy studies of the commonality between Army's *SAM-D* and the Navy *ASMS* have been completed and submitted to DOD. Project sources say that in addition to ferreting out areas of commonality, there is a requirement for maximum compatibility between the two systems.

AF, NASA Agree to Agree

Gen. Bernard A. Schriever, director of the *Manned Orbiting Laboratory* program, and Dr. George E. Mueller, NASA Associate Administrator for Manned Spaceflight, met last week to establish a formalized agreement for coordinating scientific experiments to be flown aboard *MOL*. "I can assure you that we will have a coordinated program," Gen. Schriever later told a National Space Club luncheon. He also said studies of 60 and 90 missions for *MOL* are in progress.

NASA Budget To Be Over $5 Billion

Reports that the Administration has asked NASA to keep its FY '67 budget request below $5 billion have been labeled completely false. Currently, the space agency and Bureau of the Budget are about $300 million apart in their discussions of what the budget should be. But both the high and low figures are well over $5 billion.

Tartar-D Development To Start

Navy's Bureau of Weapons is expected to award a contract early next year for development of the Tartar-D, an advanced fire control system designed to operate with the Navy's Standardized surface-to-air missile now under development. Tartar-D represents a long-standing Navy goal of integrating weapon system fire control with the Navy Tactical Data System (M/R, March 20, p. 111). Tartar-D will allow digital data derived through NTDS to be used directly by the missile fire control. The process currently requires analog inputs to the weapon systems.

Navy Wants MOL to Look at Ships

Chief Navy input to the *Manned Orbiting Laboratory* program will be an experiment to determine whether travel by both surface and submerged ocean vessels can be monitored from a space station. Recent confirmation by *Gemini* astronauts of man's ability to see much greater detail on the Earth's surface than anticipated has spurred interest in such *MOL* experiments.

INDUSTRY

Apollo Simulator Ready for MSC

General Precision is preparing to deliver the *Apollo* mission simulator to NASA's Manned Spacecraft Center in Houston by Nov. 8. Checkout there will take about three months. This will enable the first *Apollo* crew, not yet selected, to begin training before March of next year. An identical simulator is to be delivered to Cape Kennedy by next April.

Bunker Ramo To Install Data System

NASA is negotiating with Bunker Ramo Corp. for installation and operation of a prototype document information retrieval system. Under the contract, a number of consoles will be located at various test installations and linked directly to a central computer-based depository of scientific and technical document information.

Limited Warfare Report Now Available

Looking for information on military needs in Viet-Nam? The Defense Documentation Center now has copies of a classified report, published originally in May and distributed at that time to some 70 firms, which outlines long-range Air Force limited war requirements. Title: Systems Command Limited War/Counter-Insurgency Technical Objectives Document.

AFSC Uprates Limited War Post

An expanding Air Force effort to strengthen technological support of operations in Southeast Asia has led to the assignment of Brig. Gen Henry B. Kucheman, Jr., as a deputy for limited war with the Air Force Systems Command's Aeronautical Systems Div. at Wright-Patterson AFB, Ohio.

In making the announcement at a National Space Club luncheon in Washington on Oct. 19, Gen. Bernard A. Schriever, commander of AFSC, said that Gen. Kucheman's office would provide "a single focal point which has a broad and detailed knowledge of the R&D activities that might provide technical solutions to operational needs." Kucheman will have authority to direct action in this area by any AFSC organization. ASD is AFSC's "lead division" for limited war operations.

Schriever listed two other Air Force undertakings that are allowing quick response to requirements from the field. The first involves establishment of the Southeast Asia Operational Requirement (SEAOR) operation. This essentially ties the Second Air Division by TWX communications to its Pacific Air Forces headquarters—and simultaneously to Air Force headquarters, AFSC, Tactical Air Command, and Logistics Command headquarters—for transmittal of operational needs. ASD and TAC then provide preliminary estimates for Air Force headquarters.

The Air Force has also established a new AFSC liaison office at Second Air Division headquarters in Saigon.

Schriever said there has been a rapid buildup in recent months in limited war hardware items being evaluated under Project 1559.

GTA-6 Crew To Study Comet

NASA is combining the research efforts of *Gemini 6* astronauts, high-altitude jet research aircraft and sounding rockets to study the Ikeya-Seki comet during its two-week period of maximum visibility.

The comet, which reached its peak of visibility Oct. 20, will be photographed by astronauts Walter M. Schirra and Thomas P. Stafford during the *GTA-6* mission, scheduled for Oct. 25-27. The astronauts will be able to see the comet in every orbit as they come over the horizon.

NASA's Convair 990 research aircraft will be operated at a point in the mid-Pacific about 400 mi. north of Hawaii, the best vantage point on Earth for viewing the comet. Four *Aerobee* sounding rockets will be fired from Wallops Island, Va., and White Sands Missile Range, N.M., to make observations.

Titan III-C Break-up a Mystery

There still were no clues late last week as to why the Transtage of an Air Force *Titan III-C* broke up in orbit after successful launch from Cape Kennedy on Oct. 15.

The problem appeared likely to set back launch of the third *Titan III-C* scheduled for early December. The Transtage apparently suffered a catastrophic failure after its second burn over Carnarvon, Australia, 56 min., 10 secs. into the mission.

It also appeared that the failure wiped out the *OV2-1* radiation monitoring satellite and the Lincoln Laboratory 75-lb. passive radar calibration sphere, which the Transtage was to have ejected. MIT's Lincoln Laboratory said it had not been able to locate anything among the debris that behaved the way the sphere would.

Northrop's *OV2-1* satellite was not scheduled for turn-on until after the third Transtage burn.

Telemetry tapes from Carnarvon were flown to Cape Kennedy for analysis in an effort to determine what led to the tumbling and break-up of the Aerojet-General Transtage.

First space test of the Rocket Research Corp. subliming solid thrustor, hailed as a major innovation in spacecraft attitude control, was also lost with *OV2-1*.

Radar reports said at least three pieces of the Transtage and/or satellites were being tracked in a circular orbit of some 460 miles, but identity of these was not established.

After the scheduled Oct. 14 launch of the *Titan III-C* was delayed for more than 24 hours by a combination of fueling problems, battery trouble and weather, the vehicle lifted off cleanly in a successful demonstration of its UTC 120-inch solid boosters and Martin Co. core stage. The Transtage ignited at T plus 7:52 as programmed and burned as scheduled for injection into proper orbit of 407 n. mi. apogee, 101 n. mi. perigee with a period of 93.9 minutes, all near-perfect parameters.

At apogee over Carnarvon at T plus 55:47, the Transtage was started a second time to circularize the orbit at 399 n. mi. The radiation calibration sphere was to have been released 1 minute and 14 sec. later. The Transtage shut off after 23 sec. of a programmed 24 sec. burn. At this point a "catastrophic change" occurred in signals from the satellite.

Evidence indicated that the stage began tumbling at this time, but pending analysis of the data, there was no clue as to the cause.

Paper Rocket Parts Study Let

The substitution of paper/phenolic laminates in place of metal and reinforced plastic rocket motor inert components will be studied and demonstrated by Thiokol Chemical Corp.'s Elkton (Md.) Div. under a contract from the Air Force Flight Test Center, Edwards AFB, Calif.

The Elkton Div. has fired small, all-paper rocket motors in the past in a low-key research effort (M/R, July 20, 1964, p. 28). Besides the obvious weight reductions, the process offers substantial cost savings over the more commonly used metal and plastic parts.

$11 M Voted for SNAP-50

Final action on Atomic Energy Commission appropriations was taken by Congress last week as a conference bill including a figure of $11 million for SNAP-50 was passed by both the House and Senate and sent to the President.

The $11 million for SNAP-50 was a compromise between the Senate's $12 million and the House's $10 million for the project. Originally, the AEC requested $22 million for SNAP-50, but $10 million was slashed by the Joint Committee on Atomic Energy in the authorization bill.

Total satellite and small power sources were voted at $53.5 million, compared with an original AEC request of $70.5 million. In addition to the cuts in the SNAP-50 program, earlier action had reduced the SNAP-10A program by $6 million.

The AEC's FY 1966 budget as granted by Congress is $2,121,900,000.

GTA-6 TV Coverage Okayed

Splashdown of *Gemini 6* astronauts Walter M. Schirra and Thomas P. Stafford will be telecast live to the U.S. and Europe following

MOL lives here

The Douglas Space Systems Center in Huntington Beach, California—where the Air Force MOL (Manned Orbiting Laboratory) will be built. This master facility for the research, engineering, testing, and production of space systems and vehicles is the only major plant of its kind and size in the free world.

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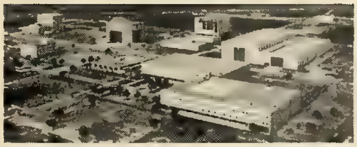


recent authorization by the Federal Communications Commission.

ITT World Communications, Inc., has been granted temporary permission to operate a transportable ground station aboard the recovery ship, USS Wasp (M/R, Oct. 18, p. 10). Transmission of the *GTA-6* recovery, scheduled for Oct. 27, will be through the *Early Bird* satellite and the ground station at Andover, Me. ITT will coordinate operations with Communications Satellite Corp., manager of *Early Bird.* Columbia Broadcasting System is representing a pool of broadcasters who will distribute the live telecast in the U.S. and Europe.

Shots of the Week

The Soviet Union last week launched the second of its *Molniya 1* communications satellites and two *Cosmos* series scientific satellites, numbers *92* and *93*. The Tass news agency says the *Molniya 1,* launched Oct. 14, carries equipment for the transmission of television and long-distance, multi-channel radio communications, a command and measuring complex, and orientation, orbital-correction, and power-supply systems. Orbital parameters for the *Molyniya* are 24,855 mi. and 310 mi. The first *Molniya* was launched April 23. *Cosmos 92* was orbited Oct. 16, *Cosmos 93,* on the 19th.

- NASA's *OGO-2* satellite was boosted into polar orbit Oct. 14 from Vandenberg AFB, Calif., aboard a thrust-augmented *Thor-Agena D.* Booms on the orbiting observatory were reported to be fully deployed early in the satellite's flight. Tracking indicates that the craft is in a higher-than-planned orbit, and period is 104 minutes rather than the intended 97 minutes.
- The Air Force's *Titan III-C* underwent its second launching from Cape Kennedy Oct. 15 after a heavy rain forced postponement of the shot the previous day (see p. 10).
- The Air Force successfully launched a *Titan II* ICBM from Vanderberg AFB, Calif., Oct. 20 toward a target in the Pacific.

National Systems Study Urged

Legislation proposing a program to apply systems engineering techniques to human problems on a national scale similar to that initiated in California by Governor Edmund G. Brown has been introduced in the Senate by Sen. Gaylord Nelson (D-Wisc.).

Nelson's bill is also aimed at utilizing the scientific and engineering talents of the aerospace industry, and harnessing them to solve sociological and community problems. In a speech before the Senate, Nelson said that it would be in the national interest to begin devoting a portion of "the talents and brains of our defense and space industries to other national goals of a Great Society. This would require no diminution in either our defense or space commitments."

The bill would authorize the Secretary of Labor to set up a program and contract with private industry or institutions of higher learning.

Surveyor Slippage Seen

The *Surveyor* spacecraft has missed its Oct. 15 date for shipment to Cape Kennedy and some NASA officials are now doubtful that it will be launched before February.

Reason for the delay given by NASA was that additional checkout of spacecraft systems is needed.

Surveyor is the first U.S. spacecraft designed to soft-land on the Moon.

The Soviet Union has tried three times. The most recent failed Oct. 7 when the retro rockets apparently malfunctioned and the spacecraft landed at 45 mph. rather than the intended 18 mph., rendering the instruments useless.

Comsat Plans Buy from Hughes

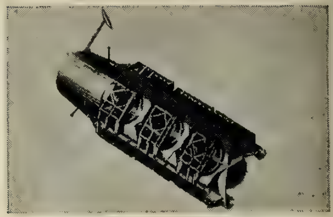
Communications Satellite Corp. plans to award an $11.7-million contract to Hughes Aircraft Co. for satellites to be used with Project *Apollo* and commercial communications services (M/R, Oct. 18, p. 10).

Comsat notified the Federal Communications Commission Oct. 18 of its intention to purchase four spacecraft from Hughes, with options to buy up to 15. Two of the satellites will be placed in synchronous orbits —one over the Pacific Ocean and one over the Atlantic Ocean. The other two spacecraft will be used for back-up and replacement purposes.

Delivery date of the first satellite will be eight months after Hughes is given notice to proceed. The others will follow at 21-day intervals.

Apollo 009 Craft Accepted

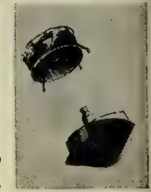
Dr. Joseph Shea, *Apollo* program manager at NASA's Manned Spacecraft Center, has approved the *Apollo* spacecraft 009 for delivery (M/R, Oct. 18, Countdown).



Multiple lander concept—Saturn V

900,000 G.E. study-hours are helping NASA achieve Voyager goals, determine configuration

What methods can be employed within the scope of present and projected technologies to achieve NASA's Mars mission objectives? General Electric engineers and scientists are now studying the Voyager mission under contract to the Jet Propulsion Laboratory for answers to this question.



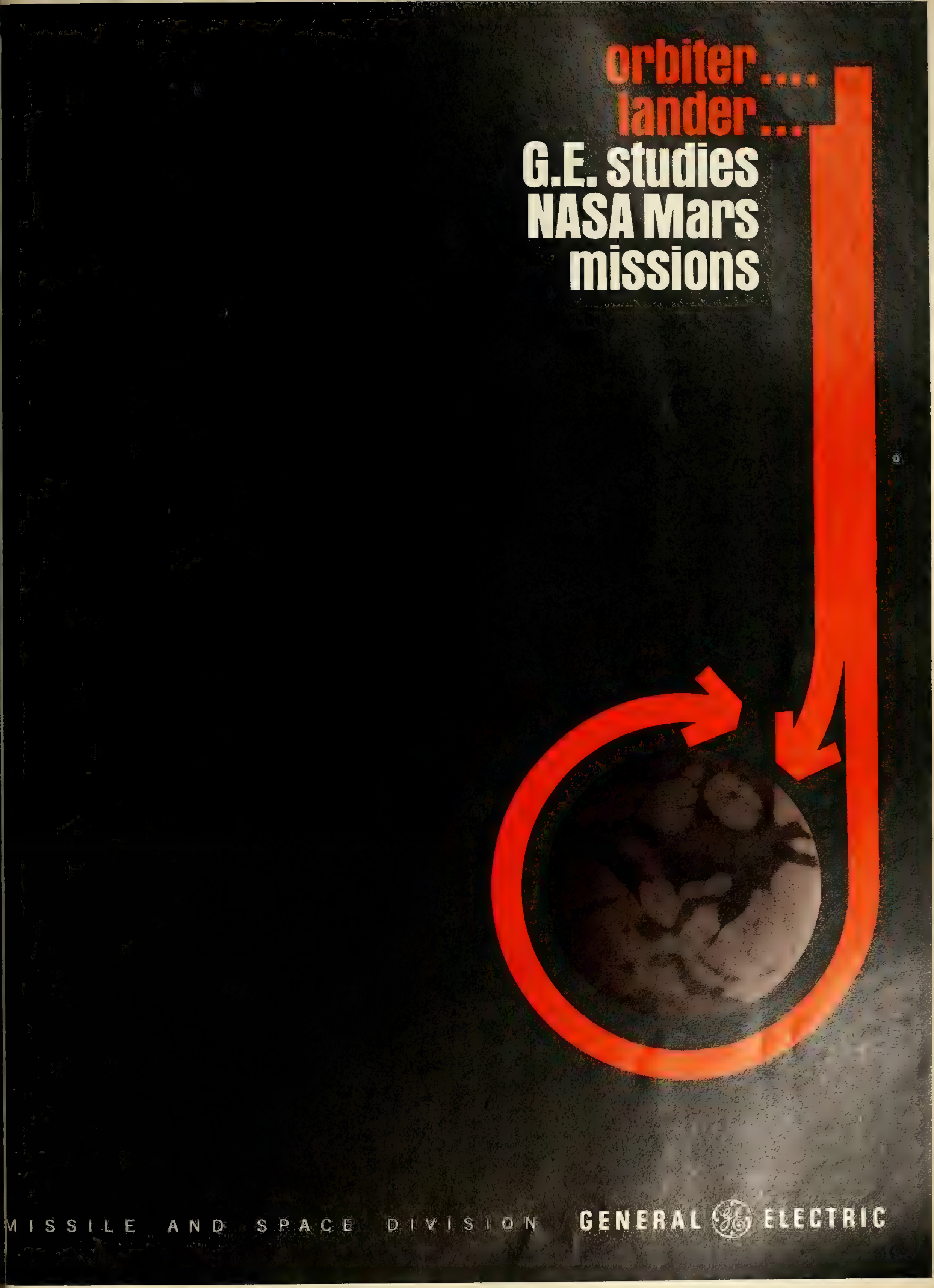
Single lander concept—Titan IIIC

Contributing to G.E.'s capability to produce these answers is solid experience—nearly 900,000 engineering man-hours in studies on planetary exploration alone—and an unmatched complex of space research facilities at Valley Forge. Included in G.E.'s planetary mission log-book are studies of possible Venus/Mars missions for scientific spacecraft launched by Saturn IB, Saturn V and Titan IIIC boosters. Prototype hardware and subsystem feasibility demonstrations have been undertaken to establish Martian entry-lander systems types. Work on the Nimbus meteorological satellite, the Orbiting Astronomical Observatory, Biosatellite plus other scientific and military programs has also contributed to over-all G-E capability.

Mariner 66 study configuration

Thus, General Electric know-how is continuing to contribute to the success of the important Voyager program—America's next major stride into deep space. 162-12

GENERAL ELECTRIC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Navy Aids Search for 'Copter Missiles

Snipe program at NOTS aimed at modifying Walleye; Shillelagh may back up TOW helicopters, utilizing new TOW sight

by Michael Getler

THE ARMY'S SEARCH for improved guided weapons for helicopters has led to a Navy effort to modify the *Walleye* TV-guided glide bomb.

The system, known as *Snipe*, is now in a "very early test phase" under Army funding at the Naval Ordnance Test Station (NOTS), China Lake, Calif., an Army spokesman reports.

Intent is to repackage the *Walleye* opto-electronic guidance system into a much smaller and lighter weapon. The Army is said to be seeking a weapon in the 50-60 lb. category, in contrast with the present Navy *Walleye*, believed to weigh several hundred pounds.

Snipe, like *Walleye*, has no propulsion system. In a helicopter role, it would make use of the aircraft's forward motion at launch to "push" it toward its target. *Walleye* normally is "dropped" from an aircraft, using the glide from higher altitudes to achieve its stand-off range (M/R, Oct. 18, p. 21).

Successful development of TV-guided weapons would give the Army a much-sought-after "shoot and scoot" capability for its rapidly expanding force of armed helicopters. Missile-equipped craft at present are hampered during launch operations by the requirement to stay at the scene for an inordinate amount of time and keep within a flight envelope too restricted for evasive action.

Although planners think it may be four or five years before new opto-electronic guided missile systems can be adapted for helicopter use, the current search for new techniques is widespread. Guidance studies of TV, infrared and radar being pursued by the Army Missile Command are coupled to other efforts to develop new target-acquisition sensors—in particular, detectors that can penetrate heavy jungle growth.

- **Other avenues**—All of this is part of an overall Army push to come up with new weapon systems designed from the start for helicopters, rather than continuing to modify already developed ground-based weapons.

In addition to *Snipe*, Army experts in this area say they are closely monitoring the Air Force development program on the *Hornet* missile, also a TV-guided, air-to-surface weapon, which is still in a pre-contract definition phase (M/R, Oct. 18, p. 21).

Use of weapons guided in this fashion would actually represent a third generation of helicopter missile armament.

The Army is currently using the French-developed *SS-11* (*M22* is the Army designation) anti-tank missile aboard HU-1B helicopters as a hard-point target weapon in Viet Nam. Army officers admit, however, that the first-round hit probability of the wire-guided *SS-11* is quite low, and that on occasion four or five rounds are required. One redeeming feature of the missile is its low per round cost, estimated to be about $1,500.

Army planners told MISSILES AND ROCKETS that use of the *TOW* missile aboard helicopters, as is now contemplated, "should provide a quantum jump in first-round hit probability." The Army earlier this month awarded Hughes Aircraft Co., *TOW* prime contractor, more than $4.1 million for "research" on use of the optically-sighted, wire-guided missile aboard helicopters. The contract actually will lead to development of a prototype system within 21 months, Army officers told M/R.

Current Army plans include having *TOW* in operational use aboard helicopters in late 1967 or early 1968, according to informed sources.

- **TOW sight**—Key to the use of *TOW*, which is a tube-launched missile equipped with an IR seeker, has been the development of a new sight stabilization system. Army officers say the feasibilty of using this sight was proven last year in work performed for the Army by Hughes. Army project sources told M/R that line-of-sight accuracies for the sight have been demonstrated at ¼-mil, and even better in some tests.

One of its most important design aspects is that it provides roughly ±60 degrees of gimbal freedom for the operator to maintain the target in the sight while the missile is en route. This will make it possible to take a considerable amount of evasive action during the firing operation. A major shortcoming of the *SS-11*, according to Army sources, is that the helicopter pilot must stay along the line of sight during firing.

The *TOW* sight, linked to a computer, reportedly will feed course-correction data to the missile in flight, with the gunner required only to hold the target with the sight's gimbal tolerances.

- **Shillelagh in the wings**—Another highly important part of the new Hughes contract will be an evaluation of the potential for building the *TOW* sight and associated electronics so that it could be easily modified to fire the Army's *Shillelagh* missile. *Shillelagh*, like *TOW*, uses an IR target seeker; however, the heavier *Shillelagh*, normally a gun-fired ground weapon, is not wire-guided.

Army project sources stress that "*Shillelagh* is strictly a back-up possibility," and that the *TOW* system under development is not now conceived of as

SS-11 MISSILE, shown being fired from HU-1B, has poor first-round hit record.

a dual missile system. "It may have the capability of being field-modified to fire two weapons," they report.

Army Missile Command last week announced a contract to Philco Corp.'s Aeronutronic Div., *Shillelagh* prime, for development and test of components for a "new *Shillelagh* missile adaptation."

The *TOW* system, if developed and produced, will be used initially on the HU-1B helicopter and will also be integrated with the Advanced Aerial Fire Support System for which the Army is now pressing, if AAFSS receives a production go-ahead.

- **Wasp potential**—New activity is also expected soon, according to Army sources, in the effort to develop the small and lightweight *Wasp* anti-personnel rocket for helicopter use. An R&D effort aimed at increasing the spin rate, and hence the stability, of the spin-stabilized rocket has just been completed, it is reported. Planners now must decide whether to fabricate additional demonstration hardware.

Army officers consider the development of this one-pound, unguided missile and its zero-length launcher concept as an important potential breakthrough in helicopter armament. The unit is spun in place by a spin motor and then boosted from its flat launch platform. It does not require a rail- or barrel-type launch mechanism. ■

GTA-6 Plan Includes Four Docking Attempts

THIS COUNTRY'S first attempt to dock two vehicles in space will be made Oct. 25 if the *Gemini-Titan-Agena 6* launch takes place on schedule.

During the flight, scheduled to last two days, four separate rendezvous maneuvers will be made and five experiments conducted. The space agency also said that if all objectives of the flight are completed, the mission could be terminated at the end of one day.

Crew for the *GTA-6* mission includes astronauts Walter Schirra as command pilot and Thomas P. Stafford as pilot.

The mission was to begin with the launch of the *Atlas-Agena* from Cape Kennedy at 11 a.m. EDT. The *Gemini* spacecraft was then to be launched by its *Titan II* booster at 12:40:52 EDT.

Agena was to go into a near-circular 185-statute-mi. orbit, while the *Gemini* spacecraft sought an elliptical orbit with a perigee of 100 mi. and apogee of 168 mi. The vehicles were to be in the same plane, following the same paths over the Earth.

At its second apogee, the spacecraft will be maneuvered to raise its perigee to 134 mi. Because the spacecraft is in a lower orbit, it will be traveling around the Earth faster than and catching up to the *Agena* at the rate of 6.68 degrees per minute. This maneuver will produce a range of about 161 mi. between the vehicles at third apogee.

- **Four dockings**—At third apogee, the crew will circularize the spacecraft's orbit at an altitude of 168 mi. An hour and 11 minutes later, as the spacecraft enters darkness, the crew will begin to transfer the spacecraft into the *Agena's* orbit. At that time, *Gemini* will be 17 mi. below and 39 mi. behind the *Agena*. The initial docking could occur about a half-hour later.

Each astronaut will perform two dockings, one in daylight and one in darkness. They will separate *Gemini* from *Agena* for the last time 18 hours and 27 minutes after the spacecraft is launched. (For details of the rendezvous and docking exercise, see M/R, Oct. 4, p. 16.)

Experiments which will be performed during the rest of the flight include weather photography, terrain photography, photographing celestial bodies and the *Agena*, determining the mass of an orbiting body, and measuring radiation inside the spacecraft.

- **GT-5 lessons**—In another *Gemini* program development, Charles W. Mathews, *Gemini* manager at Manned Spacecraft Center, reported that most of the problems which cropped up during the *Gemini 5* flight last August have been solved and modifications have been incorporated into the *Gemini 7* spacecraft—scheduled to make a 14-day flight in December.

Because of the tight schedule imposed in an effort to get *GTA-6* launched on time, many of the modifications were not made in its spacecraft. This is almost certain to have no ill effect on the flight, however, because of its short duration.

Mathews listed several lessons derived from *Gemini 5:*

—*Cryogenic containers*—The 14-day hydrogen bottle in the fuel-cell reactants supply storage system has been "re-pumped" to evacuate stray molecules which may have outgassed into the hard-vacuum region between the inner and outer shells. Mathews said these stray molecules adhere to the walls of the container when the bottle is full but move out into the annulus when the bottle is half depleted, causing a higher transfer of heat into the bottle and "therefore a tendency for the bottle to heat up, vent and spill hydrogen overboard."

Oxygen containers—one holding fuel cell oxygen and the other holding oxygen for breathing—have been cross-connected by a solenoid valve to allow the heater in one tank to pressurize the oxygen in the other tank if necessary. The breathing-oxygen bottle has been equipped with a back-up heater, he said.

"All the gases that vent out of the spacecraft will pass through the center of gravity to prevent putting moments on the spacecraft."

—*Pogo effect*—The higher "Pogo" oscillation experienced by the crew during *Gemini 5* was attributed to the oxidizer level in the standpipe, which is designed to "de-tune" the oscillations, Mathews explained. The up-and-down vibration originates from irregular pumping of fuel, thereby causing an unsteady burning in the *Titan II* first stage. The standpipe evens out the flow of propellants to the engine. Mathews said the oxidizer standpipe was improperly loaded. "The liquid level was not at the level we wanted it to be. Hence, the large oscillations."

—*Telemetry dropout*—Dropout during a portion of launch was traced to a loose terminal from the DC to DC converter to the TM programmer, he said.

—*Rendezvous radar*—The spacecraft radar was able to interrogate the L-band transponder set up on a tower near Cape Kennedy from "such surprisingly long ranges as 600 to 700 nautical mi.," Mathews said. The exercise was a little extreme for the equipment in that the closing velocities were about 50 times greater than called for in the design of the equipment. Nevertheless, he said, the computer began to collect radar data at its designed range of 250 n. mi. and "began giving very good solutions."

Hercules, Thiokol Win Poseidon Work

Propulsion development selection completes major contractor team; contracts represent some $90 million; no new subcontractors likely

SELECTION OF Hercules Powder Co. and Thiokol Chemical Corp. as subcontractors for development of motors for the Navy's *Poseidon* missile completes the team of major contractors and signals the end of the contract definition phase in the new fleet ballistic missile program.

Navy's Special Projects Office last week approved the selection by Lockheed Missiles & Space Co., *Poseidon* prime contractor, of a Hercules/Thiokol team to serve as associate contractors for the first stage, and a solo effort by Hercules on the second stage.

The contracts, which will become effective when full-scale development of *Poseidon* is approved by Defense Secretary Robert S. McNamara and the prime contract is signed with Lockheed, are expected to be worth a total of about $90 million, according to sources close to the project. Development time, including prototype fabrication, is expected to be about 50 months.

Top Navy sources told MISSILES AND ROCKETS that final reports from contractors carrying out project-definition-phase studies on other major *Poseidon* systems were submitted to the Navy last week. Several of these reports involved studies of potential trade-offs made to determine how any departures from original design would interface with other systems.

Navy review of these studies is expected to last about one month, according to Navy sources, with a resultant recommendation to the Director of Defense Research & Engineering. Action by the Secretary of Defense on initiation of full-scale development is not expected before December, according to high-level sources.

- **Competitive breakthrough**—The propulsion subcontract represented the only major subsystem of *Poseidon* for which there existed a provision for a competitive contract-definition phase. All other major subsystems, including fire-control, guidance, navigation, and launching system, were let as non-competitive awards to the same firms involved in those areas of *Polaris* development.

Definition-phase contracts for propulsion were let in April of this year to both Hercules and Aerojet-General Corp. Aerojet, supplier of the first-stage propulsion system for *Polaris,* bid on both stages of *Poseidon.*

In addition to its interest in viewing competitive propulsion technology, the Navy is also known to have been keenly interested in introducing cost competition in this area.

- **New flexibility**—Primary advantage that *Poseidon* will introduce into the U.S. strategic force structure when it becomes operational, probably in 1969, will be flexibility—both in the types of target it can attack and the amount of damage it can inflict.

The missile is 3 ft. longer than the 31-ft. *Polaris A-3*; its diameter of 6 ft. is 1½ ft. wider. *Poseidon* will have the same nominal range as the *A-3,* 2,500 nautical miles; however, it will have twice the payload and twice the accuracy. In announcing the program earlier this year, President Johnson said "its effectiveness against a hardened target will be some eight times greater than the latest version of *Polaris.*"

Use of the added payload capability will allow the Navy to make trade-offs in warhead size versus number and types of penetration aids, dependent upon the type of target. Navy officers told M/R that *Poseidon* is being designed so that these payload alterations can be made easily in the field.

The *Poseidon* onboard computer and the shipboard fire control system under development are both believed to involve considerable expansion in capacity to handle increased targeting flexibility (M/R, April 19, p 21).

Development effort for *Poseidon* has been pegged by McNamara at about $900 million, and Navy sources say that the project is within cost estimates thus far. An additional $1.1 billion has been estimated for the cost of retro-fitting 19 submarines to handle *Poseidon.* ■

Hercules To Manage Joint Propulsion Effort

HERCULES POWDER CO. will manage the entire propulsion system for the *Poseidon* missile. The firm's responsibility includes both first and second stages.

Hercules will design and develop the entire second-stage propulsion system. The first stage will be designed by Hercules, which will supply glass-reinforced motor cases to Thiokol Chemical Corp. Thiokol will load these cases with their propellant formulation—a composite-type grain. The second stage will use a double base-type propellant.

Both first and second stage cases will be glass-reinforced plastic structures, designed and wound by Hercules at its Clearfield, Utah, facility. Brunswick Corp., which is licensed by Hercules for second-stage cases on the *Polaris* program, probably will be involved in the *Poseidon* work as the program effort increases.

All propulsion work will be done in Utah, at Hercules' Bacchus facility and Thiokol's Wasatch Div. The thrust-vector-control system for *Poseidon* is a Lockheed Missiles & Space Co. responsibility.

No new subcontractors are expected to be involved in the *Poseidon* propulsion development program. Hercules officials indicate the same contractor teams now working on the *Polaris A-3* program will later move into the *Poseidon* effort.

Management procedures proven successful on *Polaris* will be applied to the *Poseidon* work by Hercules—including a computer-oriented production-control concept now being used by the firm in its *Minuteman* production.

J. D. Hayes, general manager of Hercules' Explosives and Chemical Propulsion Dept., told M/R he was extremely pleased with the "excellent cooperation" existing between two normally competitive firms—Hercules and Thiokol. Hayes said this joint relationship during the propulsion competition was a credit to both firms.

Seamans Crystallizes Voyager Plans

Space agency to select spacecraft prime contract this winter; Apollo Applications program still lacks definition

by Hal Taylor

ASSOCIATE ADMINISTRATOR Robert C. Seamans, Jr., reports that NASA will select a prime contractor for the *Voyager* spacecraft this winter, but that another eight to 10 months will be spent in in-house studies of a probe that will be sent into the Martian atmosphere in 1971 and a capsule to land on the surface in 1973.

Dr. Seamans also told MISSILES AND ROCKETS that funding in Fiscal Year 1967 for the *Apollo* Applications program, if approved, will primarily cover long-lead-time items such as the experimental payloads for the first few flights. He added that procurement of spacecraft for the program will not be initiated for another year.

The NASA official's comments on the future programs were made as the space agency officially confirmed that the *Saturn V* would be used as the booster for the *Voyager* spacecraft. (M/R Oct. 4, p. 14.)

Plans for the 1971 mission, Seamans said, now call for the *Saturn V* to launch two spacecraft per launch toward Mars. After the spacecraft go into orbit around the red planet, each will launch a probe into the Martian atmosphere.

Data collected by the probe would be sent back to the spacecraft for transmission back to Earth. "We are allowing ourselves eight to 10 months of inhouse study to decide exactly what kind of job probe we need," Seamans said.

- **Probe design question**—One question to be answered is whether the probe should be structurally similar to the landing capsule NASA plans to land on the Martian surface in 1973 or whether it should have an entirely different design.

It is expected that whatever design is selected, one prime contractor will be named to develop the probe and the capsule. Procurement action appears to be about a year away.

Contracting action for the *Voyager* spacecraft continues Oct. 25 as The Boeing Co., General Electric Co., and TRW Systems Group will submit bids for two-month continuations of their design studies.

Their contracts were lengthened to include changes necessitated by the switch from the *Saturn IB-Centaur* to the *Saturn V* booster. The final competition among the three firms will be held when the new extended studies are completed, and a single contractor will be named.

Seamans said the switch to the larger *Saturn V* would not cause an appreciable increase in the total cost of the *Voyager* program. He said that cost of developing the new *Saturn IB-Centaur* would have been just about equal to the cost of procuring the *Saturn V*, which is already under development.

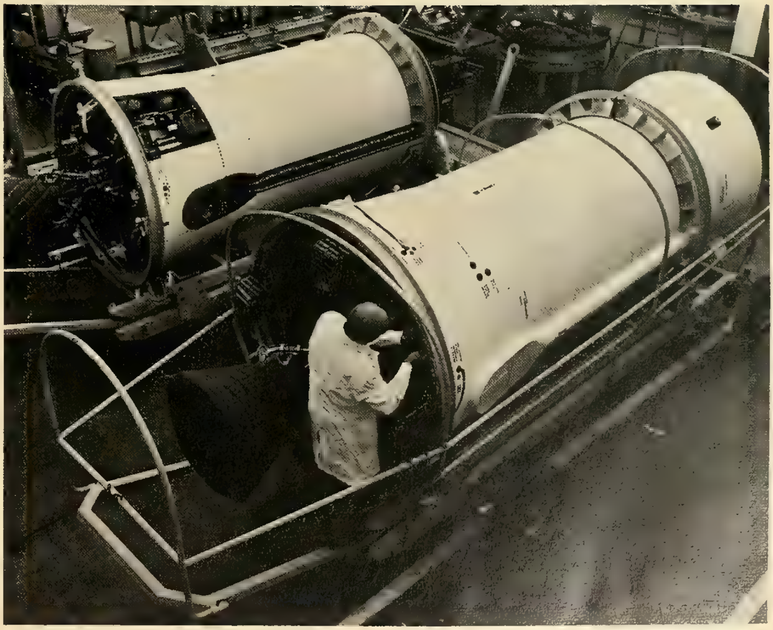
He also noted that while some design studies of the use of *Saturn V* will have to be funded, actual payment for the boosters will not have to be made until FY '69.

The late payment is a decided advantage because of the budget squeeze NASA finds itself in as it attempts to make a start on both *Voyager* and *Apollo* Applications in its FY '67 fund request.

- **AA uncertainties**—Seamans said plans for the *Apollo* Applications program are not nearly as clear as those for *Voyager* and that the manned spaceflight program will have to be considered on a flight-by-flight basis.

Systems definition, if the program is finally approved, will have to be initiated in the current fiscal year. For the next couple of fiscal years, any funding would be used primarily to pay for experimental payloads for the flights.

The decision to procure follow-on *Apollo* spacecraft for the program will not be made for about a year. If it is approved on a flight-by-flight basis, Earth orbit and lunar orbit missions would have the earliest priority. ■



New Delta Second Stage in Debut

FIRST ASSIGNMENT for larger second stage of Douglas Delta launch vehicle will be in the Nov. 2 launch of the Geos geodetic satellite. The stage is 54½ in. in diameter, compared to 32 in. for its predecessor. Improvements include a 400-second burn time, compared to 150 seconds for the previous stage, a restart capability and 7,890 lbs. of thrust compared with 7,575. The stage has an Aerojet-General propulsion system and a Douglas-built guidance system. Delta has 30 successes in 33 launches.

Funding Boost Might Cut Apollo Cost

House Space Committee staff report finds that extra $200 million now would help insure Moon landing date—and eventually spell savings

NASA APPEARS to have well in hand some major and minor problems posed by the pacing systems for the *Apollo* lunar landing program. But additional funds of around $200 million would provide additional assurance of meeting the goal, says a House Space Committee staff report.

The NASA Legislative Oversight subcommittee, chaired by Rep. Olin Teague (D-Tex.), recently commissioned a staff survey which reached these conclusions on the progress of the *Apollo* program, now at the midpoint in its goal of landing on the Moon by 1970.

NASA is effectively employing its resources in the solution of these pacing system problems, the report found, and thus giving confidence to the attainment of the *Apollo* goal. However, NASA officials including Gen. Samuel Phillips, Headquarters *Apollo* director, and *Apollo* Program Manager Dr. Joseph Shea conceded that additional funds could be utilized now to bring about further improvements that would eventually yield savings in the program.

Crucial systems on the Lunar Excursion Module were identified as being the descent engine, the ground support equipment, the rendezvous radar, and overall weight growth. On the Command and Service Module (CSM), problem areas were identified as engineering drawing releases which are running behind schedule, subassembly delivery and certification, and fabrication and tooling of the bonded structure. All major problems should be solved by 1968, NASA said.

• **Spend now, save later**—NASA officials cited the value of increasing funding to these areas to allow an alternative development project in support of the main effort. The staff report concluded that an extra $200 million in Fiscal Year 1966 would increase the assurance of achieving a lunar landing in this decade, give broader latitude in providing system alternatives when engineering difficulties are identified, and give management more freedom to utilize NASA resources.

One apparent possibility is that without a supplemental, the FY 1967 budget may eventually run above the projected monthly *Apollo* spending rate. This might be necessary in order to solve the problems in the LEM and Command and Service Module areas, and to meet contractors' stated requirements for more funding to get on top of engineering releases and qualification schedules.

Present monthly funding for *Apollo*, roughly $260-270 million, is programmed to decline to something between $200 to $250 million a month during FY 1967. However, according to NASA's own estimate, it could remain near the present level into about the middle of FY 1967.

In addition to the spacecraft question, Phillips said he felt some concern as to whether the network functions of mission control, mission planning and trajectory work can all be carried out for both *Apollo* and *Gemini* missions within the authorized budget.

Shea said NASA is running "tightest" in its qualification testing of the spacecraft subsystem, and that if it had more resources it could progress more quickly. Qualification dates could be advanced from two to four months, he estimated, reducing the total cost of the program by about $300 million by advancing the lunar landing date.

• **Breakdown**—Phillips said that on the first unmanned *Saturn IB* flight, scheduled for 1966, problems falling into the minor weakness category include the instrument unit, which had its problems with late engineering releases, late delivery of components, and late availability of the operational checkout station. However, overtime and multiple shifts have been invoked, and Marshall Space Flight Center is giving the contractors increased assistance.

Also lagging is ground support equipment, and this could put the first *Saturn IB* launch behind schedule. There has been delay in service structure modification because of strikes and weather, as well as in installation and checkout activities due to late delivery of equipment. Management has acted to alleviate the situation.

For the first manned *Saturn IB* flight, planned for 1967, schedule slippages have occurred with the Block I Command and Service Module because of late engineering releases. In addition, problems have been identified in the fabrication area and in subsystem delivery and certification. Cost is a further problem.

In this case NASA has instigated a continuous review of the program's technical, schedule and manning requirements; redirected the scope of the unmanned missions; realigned qualification and ground test programs; and reduced system checkout and preflight operation flow times. At the present time, it appears that the problems will have minimum impact.

Engineering releases in the ground support area are also troubling the CSM. In the network area, some of the stations are not expected to be ready for the first manned flight, although NASA is making sure that minimal support will be provided.

On the first manned lunar-configuration spacecraft, due for launch in 1967 by the *Saturn IB*, difficulties with the LEM and GSE fall into the major weakness category, with the Command and Service Module in the minor bracket.

In the case of the CSM, late design releases again have caused worry, but the transfer of engineers from the Block I to Block II has been accelerated.

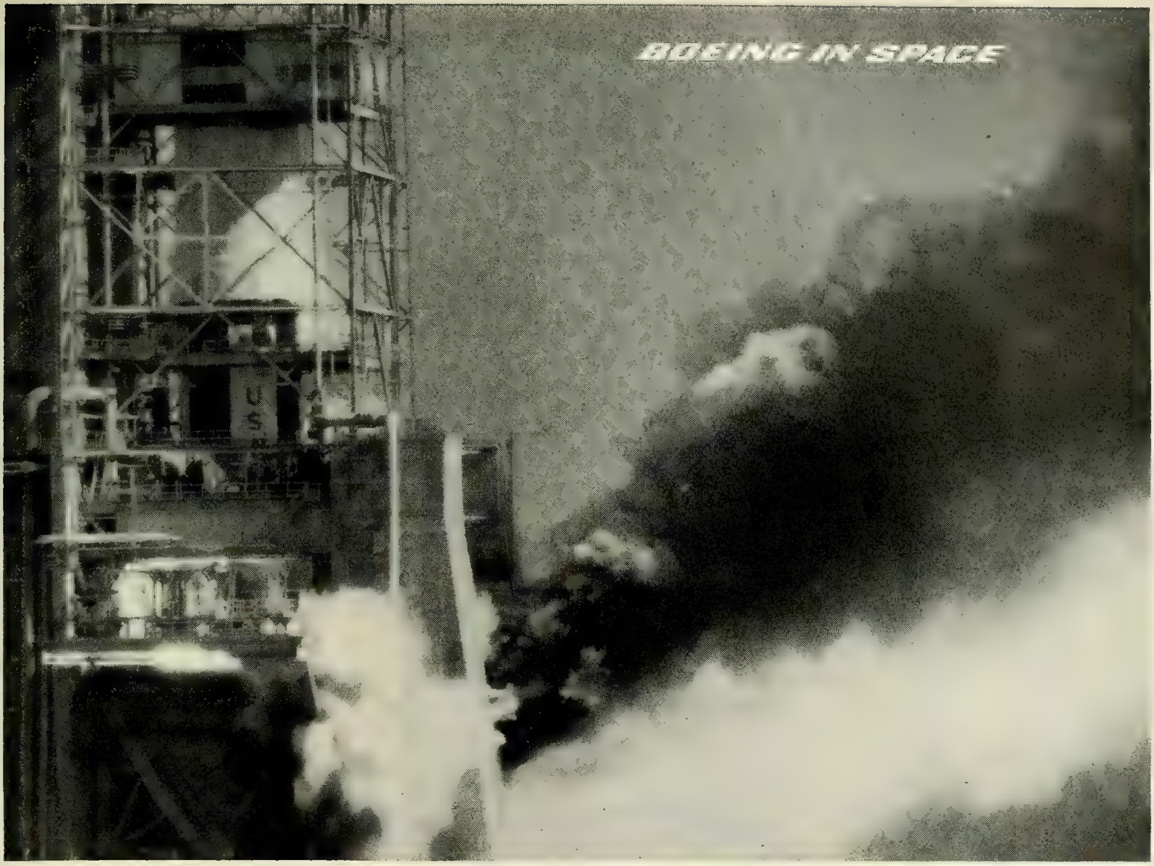
LEM headaches have arisen in development of subsystem design, schedule slippages in ground-test and flight articles, and ground support equipment. There are additional difficulties with weight and cost growth.

Extensive contractor reviews have been conducted by NASA, and a detailed program control plan has been implemented. It is now being determined whether or not the problems will cause a slippage in the schedule of this flight.

• **Saturn V**—The first unmanned *Saturn V* flight, scheduled for 1967, also faces slippage problems, involving the S-II stage. Late engineering releases are causing fabrication delays, and there are technical obstacles in common bulkhead development, the battleship firing program, and component qualification.

The test program for the S-II stage has been shortened and aligned, overtime has been authorized, and the Mississippi Test Facility, which is behind schedule in completion, has had its management reorganized.

GSE problems will not affect the launch schedule for the first *Saturn V*, NASA said. While there have been late deliveries, assistance is being provided to the contractors, and a site activation force has been inaugurated by NASA. ■

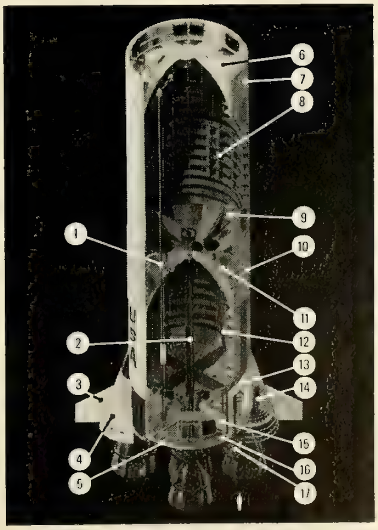


Smoke, steam and flame mark the successful first full-duration test firing of the world's largest rocket booster—Saturn V's S-IC first stage. All five Rocketdyne engines of the S-IC, shown firing simultaneously at NASA's Marshall Space Flight Center, are generating the most force ever produced by a rocket—7.5 million pounds of thrust, roughly equivalent to 160 million hp in flight.

NASA's Marshall Space Flight Center and Boeing are jointly developing and testing Saturn V's S-IC booster. Saturn V—tall as a 30-story building and weighing 3,000 tons — will launch men and equipment into earth orbit, lunar orbit and deep space probes. It will be able to launch 100 tons into earth orbit or propel several tons of instruments to Mars.

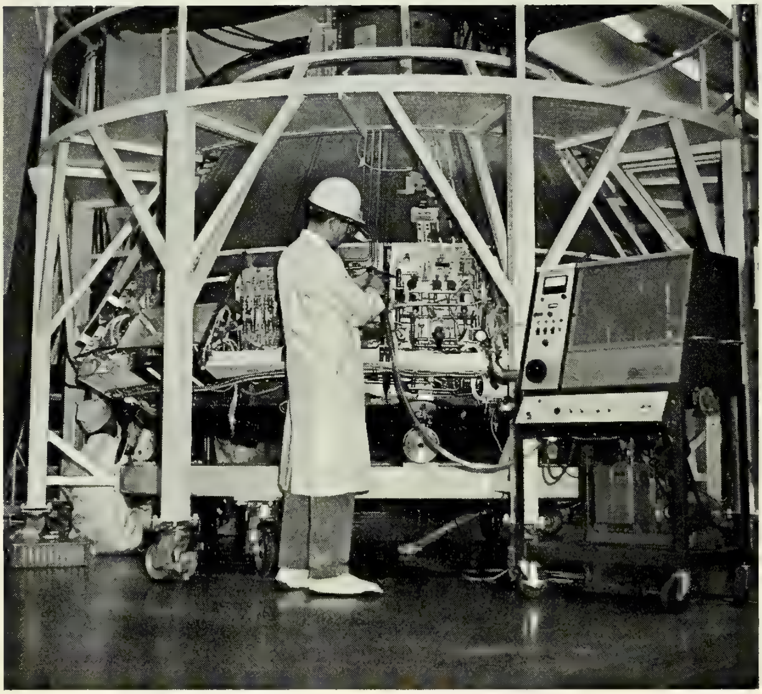
NASA's Saturn V will launch American astronauts to the moon this decade. **BOEING SPACE DIVISION**

Saturn V S-IC



1. GOX line
2. Oxidizer suction lines
3. Fin
4. Engine fairing
5. Umbilical panel
6. Oxidizer tank
7. Forward skirt structure
8. Helium bottles
9. Anti-slosh baffles
10. Intertank structure
11. Fuel tank
12. Suction line tunnels
13. Upper thrust ring
14. Retro rockets
15. Center engine support
16. Lower thrust ring
17. F-1 engine

CEC Leak Detector proves leak tightness of Apollo Spacecraft



North American Aviation's Space and Information Systems Division is making certain that all systems in the Apollo Command and Service Modules can pass rigid leak inspection by using CEC's 24-120B Leak Detector.

In the Command Module, in which three astronauts will pilot the spacecraft from Earth to Moon orbit and return, cabin hatches and seams plus more than 500 gold-brazed joints are checked and rechecked by using the 24-120B. Leaks as small as 2×10^{-8} atm cc/sec/div of helium must be located and sealed.

Furthermore, each of the joints in the systems used to steer the spacecraft and maintain its "shirtsleeve" environment is required to meet standards that assure leak integrity in the vacuum of space – as well as during the heat of re-entry when external temperatures reach an awesome 5000°F.

Similar tests are applied to all joints and seams in the tanks, lines and engines of the Service Module and the giant Saturn S-II second-stage booster. In the S-II stage, a pressure of 36 psi is required in the liquid hydrogen tank, which makes constant leak tightness an absolute necessity.

In these and other programs, CEC's 24-120B has proved to be efficient, reliable, and versatile. Is it any wonder that the 24-120B Leak Detector has become the ideal answer for virtually every critical leak checking application, from bench-top to mobile testing?

Primary advantages:

▣ Detects and locates leaks as small as 5×10^{-11} atm cc/sec/div of helium.

▣ Can detect as little as one part of helium in 10 million parts of air.

▣ Less than 1 second is required to produce 50% full-scale deflection on x 1 scale of leak rate meter.

▣ Built-in automatic protection valve guards leak detector vacuum system against external pressure bursts.

▣ Includes high-conductance roughing valve permitting use of 15 cfm pumps for fastest pumpdown yet devised.

A complete line of accessories to meet every conceivable need:

- Audio Alarm
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- Adjustable & Fixed Sampling Probes
- Multiple Valve Fast-Response Inlet Manifolds
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For complete information about the 24-120B, call or write for CEC Bulletin 24120B-X28.

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Technical Countdown

ASTRONAUTICS

Micrometeoroid Composition To Be Checked

Instrumentation designed to reveal the chemical composition of micrometeoroids in deep space will be developed by Avco's Research and Advanced Development Div. under a $98,000 contract from NASA's Manned Spacecraft Center. The procedure involves the use of inert-gas-filled plastic balloons deployed from an orbiting satellite. Micrometeoroids puncturing the balloons and traversing the gaseous atmosphere within will be aerodynamically heated. The emitted light will be piped by fiber optics to a miniaturized spectrograph, which will analyze the emission and extract information on the micrometeoroid composition.

LTV Designs New Space Simulator

A new simulator under development by LTV, Inc., for Ames Research Center will be used in human factors studies to advance technology in controls, displays, maintainability, crew layout, and rescue systems for manned spaceflight. Long-duration flight simulation will be provided in the capsule by adding life-support, environmental-control, vibration and noise, restraint, and physiological monitoring systems. The capsule will be used in determining human factors design requirements for future space vehicles.

ELECTRONICS

Microcircuit Techniques Applied to Tubes

Thin-film deposition techniques developed for microcircuits are being used by Raytheon Co. to raise the performance of microwave tubes. Improved performance has been demonstrated with carcinotrons and backward-wave oscillators for C and Ku bands. Interdigital structures of copper were laid down on beryllia by vacuum deposition and photo-etching. A tube of this type has delivered 35 watts and is expected to give 50 watts. TWT slow-wave structures can be produced in a similar way, and other tubes are being investigated for the technique, particularly for high-temperature operation. In cross-field amplifiers, complex structures can be made that are impossible by other means. Thin films of titanium boride are proving highly successful in preventing multipactor at high power levels.

Filter Gives Fast Scan of Visible Spectrum

A variable wavelength color filter scanning the entire visible spectrum has been demonstrated at North American Aviation's Autonetics Div. A Christiansen filter containing a pinene, amyl acetate, isopropyl alcohol mixture showed a pressure shift of wavelength of 5 Angstroms per atmosphere. Bandwidth of the filter was 150 Angstroms at 70% of peak transmission. For improved designs, scanning speeds of 10^{10} Angstroms per second are predicted by E. Matovich, research specialist at Autonetics.

Microthrustor Calibrator Developed

For measuring extremely low thrusts of reaction control engines, a horizontal or torsional pendulum device has been developed by Lockheed Missiles & Space Co. as part of the *Applications Technology Satellite* program. The device can operate in a vacuum and provides a 1 volt d-c output for 50 micropounds thrust. Lower threshold of measurement is limited by building movements, which in a 24-hr. period correspond to a cyclic ± 0.2 micropound thrust. This is a serious limitation for tests of subliming rocket systems. It can be overcome with a stable platform that senses vertical with respect to gravity and provides an error signal, reports R. Steger, research engineer, LMSC.

Miniature Encoder Reads to 1.2 Arc Seconds

A resolution of 1.2 arc seconds has been reached in a hybrid angle encoder with a 2-in-dia. rotor. Developed at North American Aviation's Autonetics Div., the encoder has an optical transducer that uses a single line pattern to generate moiré fringes by a reflex technique. This compensates for shaft runout. A fully digital phase demodulator and an incremental coding technique are used. RMS error amounts to 1.7 arc seconds.

PROPULSION

Motor Case Recovery, New Binder at UTC

At least 30% of the cost of each unloaded 120-in.-dia. rocket case could be saved by parachute recovery after separation and allowing for the expense of both recovery and refurbishment. United Technology Center engineers note that the dollar saving would depend on the number of launches and number of actual re-uses. The case and associated TVC assemblies could take an impact of 60 mph using parachute deceleration from 10,000 ft. UTC scientists are also testing a solid motor using a new carboxy-terminated polybutadiene binder. The compound is fast burning, resistant to thermal degradation and resists chemical changes. Dubbed "Utrez," the high-energy binder is being developed for application to future large solid boosters.

SPACE MEDICINE

Medical Device Evolves From Aerospace Testing

Cornell Aeronautical Laboratory has developed a new small probe that can provide instant local temperature readings out of techniques learned in high-temperature testing of aerospace structures. The sensor, about the size of the tip of a ballpoint pen, is mounted on the end of a sting mount, and can be used under the skin, in body cavities, or on the surface of a subject's body. Developers see it as having applications to measuring cardiac output, study of peripheral circulation, localizing areas of disease, and for replacing thermometers or thermistor sensors.

Soviets Simulate Moon Fly-By Mission

Soviet psychologists say that a two-man crew is undesirable for long space flights since their experiments have shown that the men have psychological reactions out of proportion to the events that occur. During a recent 30-day simulated confinement in a closed test chamber—according to the Soviets the time necessary to fly around the Moon in a circumlunar mission—the nervous system was affected although the men retained their full capacity to work. The volume of the chamber was 7 cubic meters, and normal sea-level atmosphere apparently was used.

Vital Agena Unit Replaced for GTA-6

Programmer with gold-gold bonded IC's is substituted for one with gold-aluminum bonds after failure during tests of command controller

by Rex Pay

El Segundo, Calif.—A failure appearing during extensive tests of the *Gemini Agena Target* vehicle command controller led to its replacement by a duplicate device made up from a different batch of integrated circuits.

The fault in this vital element of the *Agena's* command system is thought to be associated with a particular lot of IC's with gold-aluminum bonds.

An alternative programmer has been built using integrated circuits having gold-gold bonds with a molybdenum coating. It is going through qualification tests. The gold-gold system is that reported to be used for *Minuteman II* after physics of failure studies revealed problems with gold-aluminum bonds (M/R, Aug. 2, p. 34).

Texas Instruments, which supplies the integrated circuits for *Agena* and *Minuteman II,* recently announced the availability of a molybdenum bonding technology for integrated circuits subjected to high temperatures.

The command controller is a key item in *Agena.* All commands, whether from the ground or from astronauts, before or after docking, have to pass through it before they are executed. It is the final action-taking component of the command system. It takes commands from a programmer, processes them and routes them to the flight-command logic package or directly to the *Agena* systems being commanded.

- **AF confident**—In an interview with Missiles and Rockets, Col. Alfred J. Gardner, Air Force Space Systems Division (SSD), director of the *Gemini Agena Target* vehicle program, expressed great confidence in the vehicle and its ability to go smoothly through the countdown (M/R, Oct. 18, p. 35). He said the spare controller that had been inserted had passed through a great deal of test time without failure. "We feel that the launch date is solid," he said.

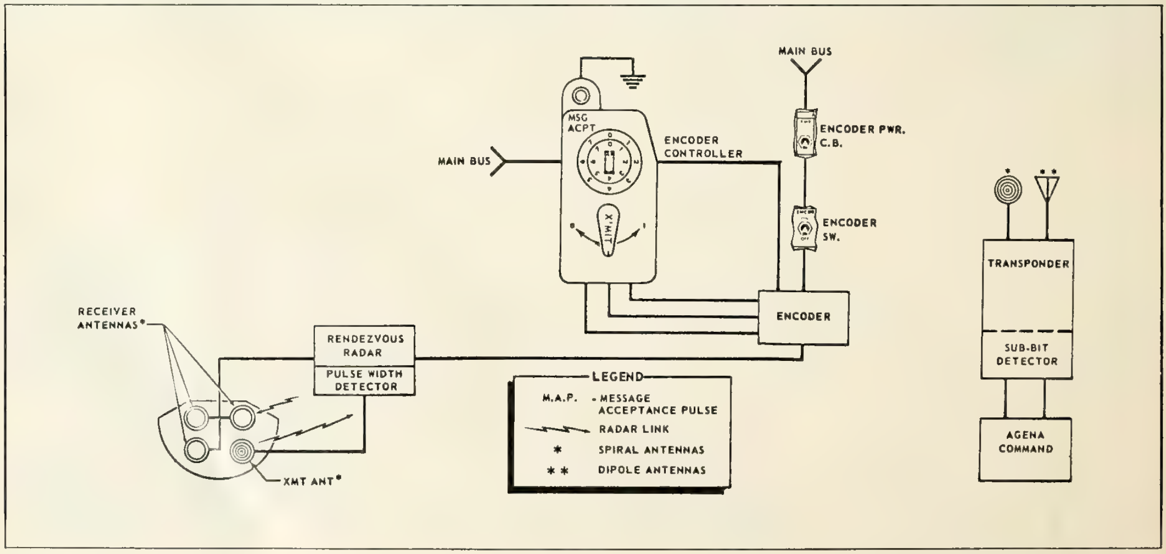
The level of quality assurance in the *GAT* has raised problems in the past and led to some reorientation of the production program this spring.

Source of the problems seems to have been a decision to purchase the *GAT* as a modification of a standard vehicle. In 1962, it was apparently thought that a standard *Agena* could be modified for the manned *Gemini* mission and not require the meticulous care needed in the launch vehicle.

For the *Gemini* rendezvous missions, *Agena* design model 37205 is being used—the vehicle numbers being 5001 through 5008. This version is equipped with a main engine with more than 16,000 lbs. of thrust and is capable of at least five major vehicle maneuvers in orbit, reports the main contractor, Lockheed Missiles and Space Company. *Agena* 5002 will be used in GTA-6.

- **Upgrading**—To raise the quality-assurance program to the required level for manned operations, Lockheed was asked by SSD to implement a 10-point plan. This included a review of the construction and design of the entire electronics command and control components in the *Agena,* with concentration on the failure areas. The level of piece-part testing in electronics was raised and a fly-by program of experimental airborne work on the memory system was expanded.

ENCODED COMMAND transmission link between Gemini 6 spacecraft and Agena target vehicle.



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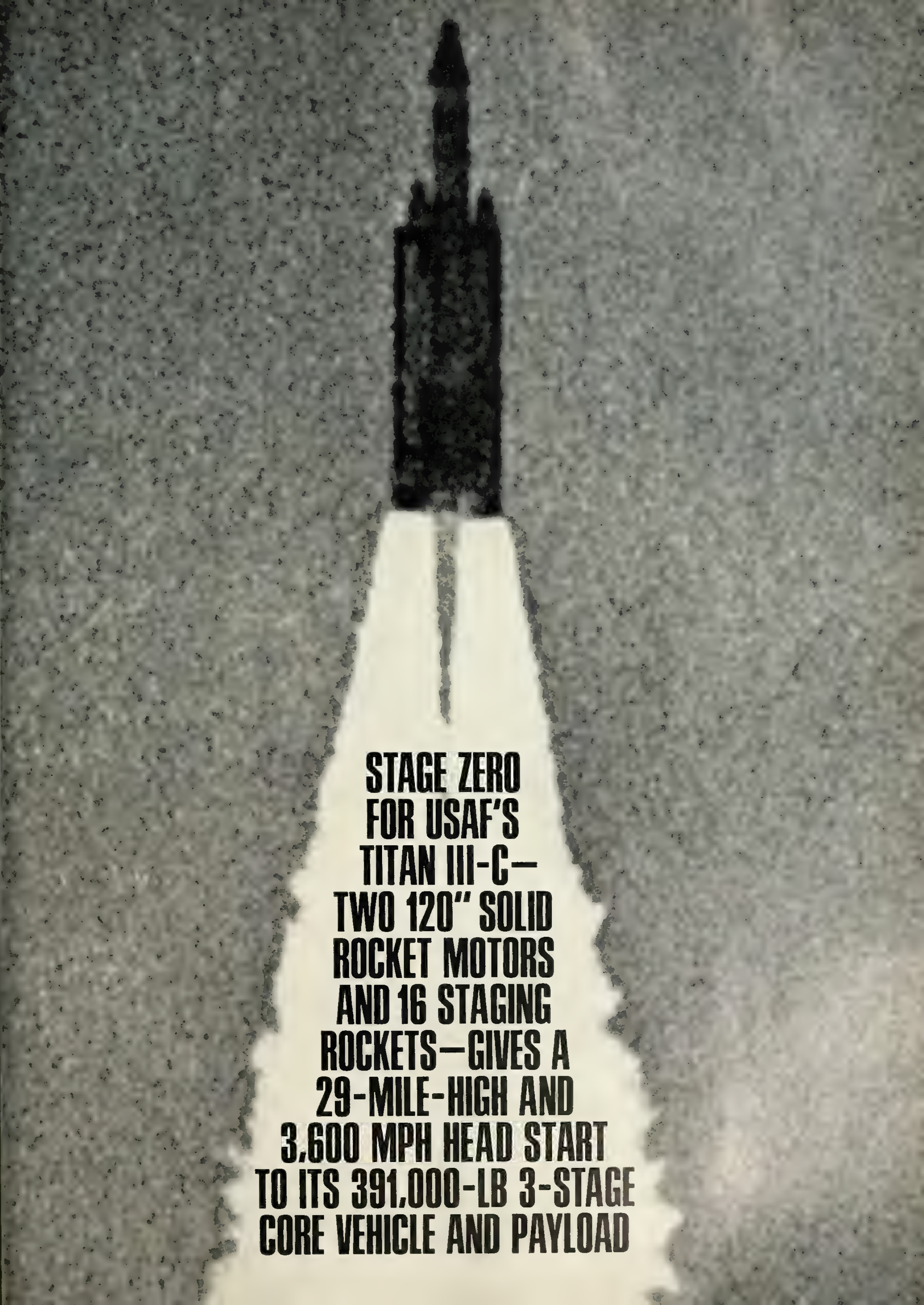
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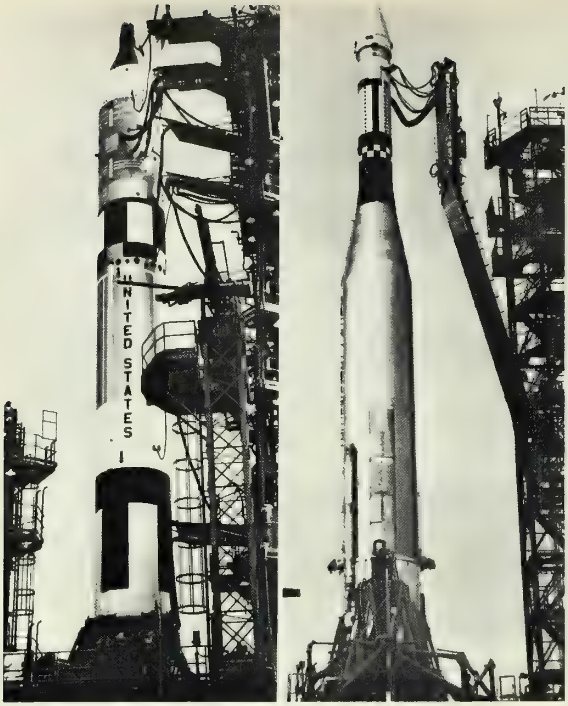

GEMINI spacecraft atop Titan II booster (left) and Agena target vehicle aboard Atlas launch vehicle shown at Cape Kennedy prior to dual launch scheduled for Oct. 25.

Faster and more thorough failure analysis was requested, together with a vendor audit. A no-rework policy was laid down for the programmer modules, and a quality control system was established in the module assembly area.

Key Lockheed staff on the project were designated as *"Gemini"* people, and the vital importance of extra care in a manned mission was stressed.

SSD asked that the *GAT* program be given top priority.

Subsequently the critical radio frequency interference tests with the *Gemini* spacecraft and *Agena* checked out very well (M/R, Sept. 13, p. 18). "In some ways, this may be the first time we have had to worry so much about RFI in orbit," said Gardner, "As the two vehicles get close together we must be very careful about spurious signals."

The RFI tests indicated that the *Agena* had an operating controller, but still unexplained was a previous fault occurring with a specific command. During more intensive testing to discover whether or not there was a problem, there was a second failure. The controller was thereupon replaced.

- **IC involvement**—Main *Agena* items using integrated circuits are a module that provides one-second pulse signals and the engine-sequencing modules that use these pulses to generate timing signals for three regimes of engine ignition and shutoff in orbit. The third module is an emergency-reset timing device that switches on the tracking beacons after a preset interval.

The programmer is in four sections. An information-bit detector verifies that a command message is addressed to the correct vehicle and converts the remaining Real-Time Command (RTC) or Stored Program Command (SPC) sub-bit message into the corresponding information-bit message. It also generates the end-of-message pluse.

The real-time section of the programmer decodes each RTC information-bit message in real time and generates the corresponding command pulse required for its execution. It also enables the storage section to receive each SPC information-bit message.

A third module houses the vehicle clock that provides timing signals for the storage section. This section stores each SPC information bit message until the appropriate time, then decodes it and generates the required command pulse.

The programmer system can handle 96 different commands, but this number is not being used in the rendezvous mission. Typically, commands switch on or off beacons, telemetry, on-board tape-recorder functions, approach lights, the *Agena* status display panel, or engine and guidance functions. Both primary and secondary propulsion systems on the *Agena* can be commanded from the ground or by the astronauts. Similarly, pitch and yaw can be commanded, at high or low rates.

- **Guidance gear**—*Agena* normally flies in a roll-stabilized mode with its nose pointing in the direction of flight. Maneuvers normally consist of attitude changes in yaw only.

Onboard is a guidance module that has an Inertial Reference Package (IRP), two horizon sensors, three accelerometers, and a velocity-meter electronics package.

The IRP (Mod III) is a strapped-down system. If the vehicle varies in attitude by more than ± 10° from any of the three IRP references axes, the IRP reference attitude is lost. Two of the three gyros are Hermetic Integrating Gyros (HIG's); the third, the roll gyro, is a Miniature Integrating Gyro (MIG). This last has a drift of 1° per hour, compared with 6° per hour for the HIG.

The two heads of the horizon sensors look out from either side of the *Agena* underbody, at right angles to its line of flight.

Within each sensor head a mirror and lens are set at 37.5° to a central axis in the head and rotated at 21 revs. per sec., producing a 75° conical scan. Optical elements are of germanium, which is transparent in the 12-20 micron infrared region. Sensing element is a thermistor cemented on the back of an immersion lens. Instantaneous field of view of the scanner is 3° by ¾°.

When the scanner looks at Earth, the rise in radiation causes the resistance of the detector to fall; when it looks at space the resistance rises. In this way a square wave output is produced. When the waves from each head are summed, a positive or negative voltage represents a positive or negative roll error.

Pitch error is derived by use of an electronic pulse generated when the longitudinal axis of the sensor optics is normal to the longitudinal axis of the vehicle. With no pitch error, this pulse should appear at the center of the top of the square wave. The displacement from this position indicates the error.

Additional circuits minimize effects of cold clouds and sunlight, principally by clamping the signal between that for a 200°K and that for a 320°K black body.

The horizon sensor package and the IRP operate together. A signal to correct gyro drift is generated by the horizon sensor and controls a torque applied to the gimbals in opposition to the drift torques.

The *Agena* accelerometer makes use of a non-magnetic slug on a beryllium-copper spring. A torque coil is mounted around the slug and two electromagnets are positioned on each side of it. As the acceleration moves the slug toward one pole piece, a pulse of current to the torque coil returns it to its middle position. The electronics produce a pulse train that indicates acceleration, at the rate of 240 pulses per g. ■

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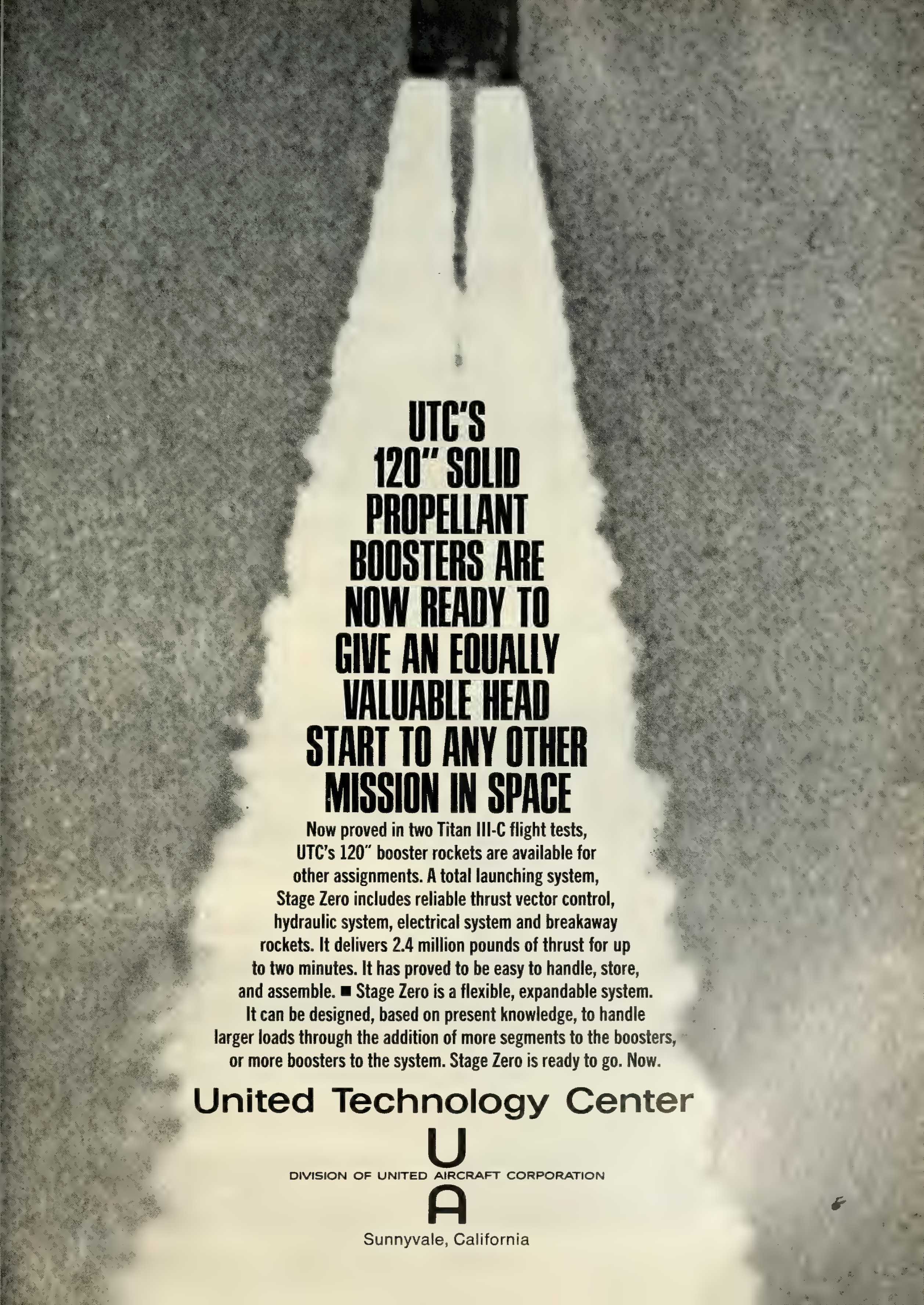

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Centaur Propellant Control Succeeds

Test of utilization system on AC-6 flight indicates close monitoring of fuel could add 220 lbs. to vehicle payload

by John F. Judge

FIRST FLIGHT TEST DATA returns from the *Centaur* propellant utilization—P.U.—system show a closed-loop error of only 5 lbs. of excess liquid oxygen out of a total flight propellant weight of 30,000 lbs.

The highly sophisticated control system thus provides a gain in payload weight of some 220 lbs. by managing the propellant outflow during flight to reduce residuals.

While the Aug. 11 *Centaur* launch was the sixth in the vehicle flight test series, it was the first flight using the P.U. system. General Dynamics/Convair, prime contractor to NASA on the *Centaur* upper stage vehicle program, showed through statistical studies that a propellant utilization system would ensure the success of the *Surveyor* missions.

Liquidometer Corp. designed, developed and manufactured the propellant sensors, electronics package and interconnecting cables for the airborne system, and also the ground-support equipment for pre-launch calibration and checkout of the flight system.

The P.U. system regulates the flow of propellants so that both tanks are emptied at the same time—minimizing errors caused by dispersion resulting from tanking, boil-off, chill-down, propellant, valve and engine performance uncertainties. In addition, the system works to achieve a preset oxygen-hydrogen ratio.

The system does this by continuously comparing the amount of propellant in each tank and adjusting the flow of LOX to the engines.

Information on the amount of propellants in the tanks is received by an onboard computer, which emits a signal causing adjustment in the flow valves located in the main oxidizer feed systems. The system is sensitive enough to "feel" approximately 1 lb. in 30,000 lbs. of propellant.

United Shoe Machinery Corp. manufactures the servo-positioner, a position drive unit that controls the operating mixture ratio of the Pratt & Whitney engines. Two RL10A-3 engines, rated at 15,000 lbs. thrust each, are mounted in the *Centaur*. A total of 69 lbs./sec. of propellant flows through these engines at a nominal mixture ratio of 5 to 1 (LOX to LH_2).

- **Onboard system**—Two sensors are installed in the LOX and fuel tanks. The unit mounted in the hydrogen tank is about 12 ft. long and is a capacitor-type liquid-quantity sensing probe. It consists of an inner tube held concentrically inside the outer jacket of the probe by a series of standoffs.

Capacitance probes were chosen because the presence of bubbles caused by bulk boiling alters the liquid density significantly from that which would be predicted for a saturated liquid. In addition, the continuous decay of ullage pressure renders undesirable the use of any mass-sensing device relying on an accurate knowledge of density.

The fuel sensor in the hydrogen tank is essentially a variable capacitance device. The inner tube serves as the high-impedance electrode. The low-impedance electrode is formed by the outer jacket. Spacing of the concentric tubes produces a given capacity.

Immersion in the liquid hydrogen causes the space between the tubes to become partially or totally filled with liquid—accompanied by a change in the dielectric of the capacitor from air to liquid.

This results in a change of total capacitance which decreases as the fuel is consumed. The five-foot probe installed in the LOX tank operates on the same principle and the choice of capacitance probes determined the electronics of the system.

HYDROGEN capacitance probe during installation in Centaur's liquid hydrogen fuel tank at General Dynamics/Convair.

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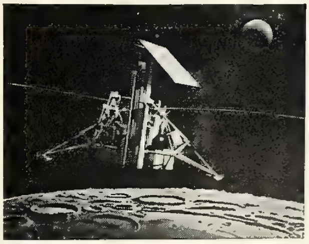

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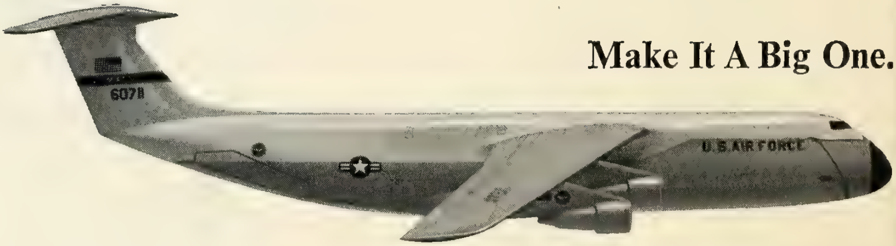

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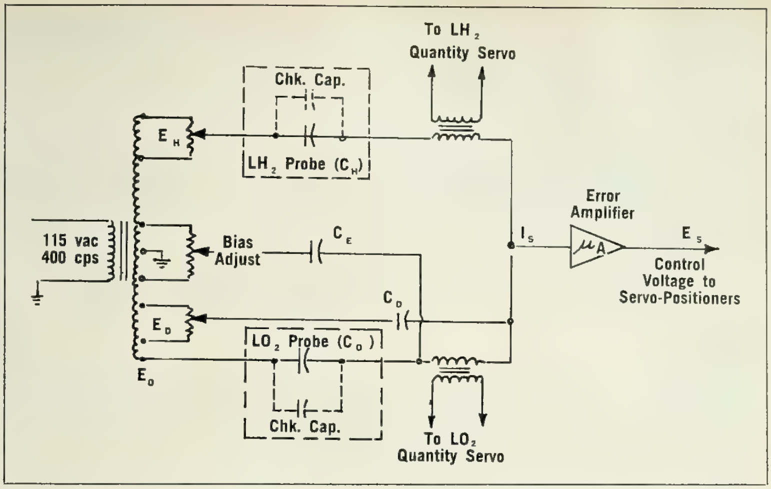

PRIMARY circuit in the electronics package is current-summing bridge in this diagram by P. M. Hanna and C. K. Perkins of General Dynamics/Convair. Dashed envelopes represent that portion of the capacitance bridge external to the electronics package—tank probes and interconnecting cables. Typical circuit parameters include: $E_H = 73$ vac. (adjustable); $E_O = 100$ vac.; $E_D = 40$ vac. (adjustable); $C_E = 100 \times 10^{-12}$ farads; $C_D = 510$ pf; $C_H = C_{HO}$ plus ΔC_H; $C_{HO} = 510$ pf (cold H_2 gas at tank empty condition); $\Delta C_H = 0$ to 110 pf (sensor empty, to be filled with LH_2); $C_O = C_{OO}$ plus ΔC_O; $C_{OO} = 170$ pf (cold O_2 gas at tank empty condition); $\Delta C_O = 0$ to 80 pf (sensor empty, to be filled with LOX); $\mu_A = 55{,}000$ (error amplifier gain); $I_S = K_S (M_E)$ (summing junction current).

A reference voltage is applied to each of the sensors, with the amplitude of the current flow through them being a function of the capacitance. This, in turn, is related to the mass of the liquid and the signals generated at the output of the two probes are proportional to the liquid mass remaining in the tanks.

These signals are tapped from terminal boards mounted on the probes and conducted via cable to the electronic package. The circuitry in this unit processes the liquid quantity signal for the *Centaur's* telemetry unit. But the chief function of the Liquidometer electronics package is to furnish signals to drive the motors of the servo positioners controlling the two LOX valves.

In processing the fuel and LOX level signals, they are fed to a propellant difference computer. The level signal difference appears at the output of the computer as an error signal. This is applied to an error signal conditioner.

Aided by a quadrature rejection network, the error signal is amplified and reshaped for application to a valve servo bridge and amplifier unit for each of the valve positioners. After further amplification, the error signal is then fed to the servo positioners.

- **Ground system**—The basic function of the Liquidometer launch support system is to receive, display and record pre-flight information pertinent to the performance of the P.U. system.

A propellant utilization digital generator is located in the transfer room at the base of the *Atlas-Centaur* vehicle launch pad. The monitor panel and readout recorder are in the blockhouse, about 0.5 mi. from the launch point.

Information received in analog form from the *Centaur* is converted by the digital generator, as one of its functions, into digital form. This is then fed to the monitor panel in the blockhouse, providing instantaneous visual indication of LOX and liquid hydrogen quantities during loading.

Digital outputs from the converter are also fed to the readout recorder, which permanently charts the propellant mass digital data on a running-time basis plus elapsed time associated with each mass quantity.

The digital generator also originates land-line and transfer room self-check test signals as well as processing static test signals from the onboard P.U. electronics package.

This static test establishes whether conditions are go or no-go as far as operation of the P.U. system is concerned, and the self-check signals determine whether the transfer room and land lines are in working order.

A self-check feature is also provided within the monitor panel and all information appears on the monitor display panel.

- **Checkout**—A fourth ground-support unit provided by Liquidometer is the P.U. checkout kit. This portable device is used to calibrate the electronics package.

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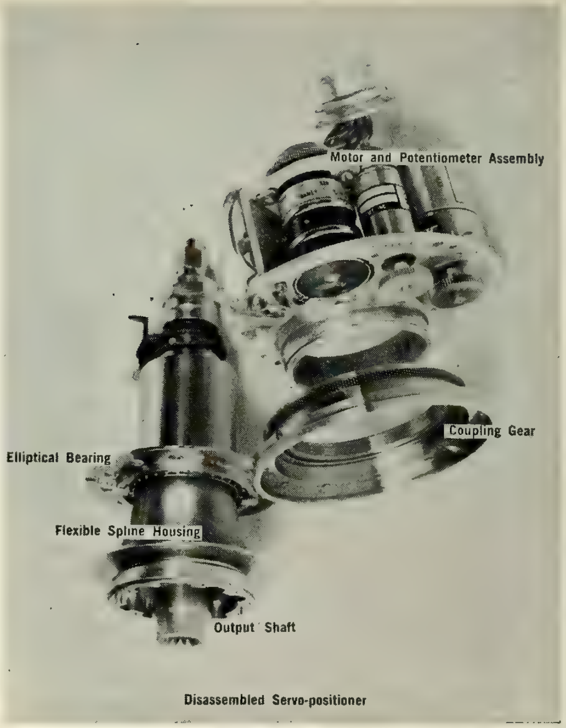
VIEW of a disassembled servo positioner used to control flow of LOX to RL10A-3 engines in currently operational Centaur propulsion vehicle. This unit is driven by P. U.-system-derived information.



Current P.U. control in the *Centaur* program is inhibited until 90 sec. after upper stage engine start by removing the capacitance-bridge error signal from the servo-positioners. This time is required for the liquid surface in each propellant tank to drop to the top of the tank sensors.

From the enabling time until the propellants reach the sensing probes, P.U. control is effective. P.U. operation after the end of probe sensing depends on the end uncovery sequence, which is, in turn, a function of the P.U. system random error.

General Dynamics/Convair has completed one flight test and 10 static firing tests with one closed-loop P.U. system. All tests were completely successful. The static test closed-loop random error fell within the band ±30 lbs. LOX. The August *Atlas-Centaur* flight (*AC-6*) error was plus-5 lbs. LOX.

System stability has been satisfactorily demonstrated at Convair. In no test, static or flight, did the flow-control valves reach their mechancial limits after correcting the initial tankage error and before the end of propellant sensing. This limit is equivalent to tank mass errors of 45 lbs. of LOX or 9 lbs. LH_2.

● **Future improvements**—Since the basic system concepts have been satisfactorily validated, the future modifications being considered by General Dynamics and NASA Lewis Research Center, *Centaur* program manager, involve changes that would increase the *Atlas-Centaur Surveyor* mission payload capability by approximately 48 lbs.

Two payload improvement changes are under consideration:

—Removing the P.U. control at the end of probe sensing, which would regain approximately 25 lbs. of the present 30-lb. payload loss associated with random valve positioning. P.U. control would be disabled by an autopilot discrete at the predicted end-sensing time relative to engine start. The LOX flow-control system would then return to the nominal 5:1 mixture ratio position.

—Modifying the electronics package to permit propellant outflow control at a mixture ratio less than the current 5:1 value. The engines would then operate at the LOX-rich mixture-ratio-stop during the earlier phase of flight to attain the desired tank propellant mass ratio.

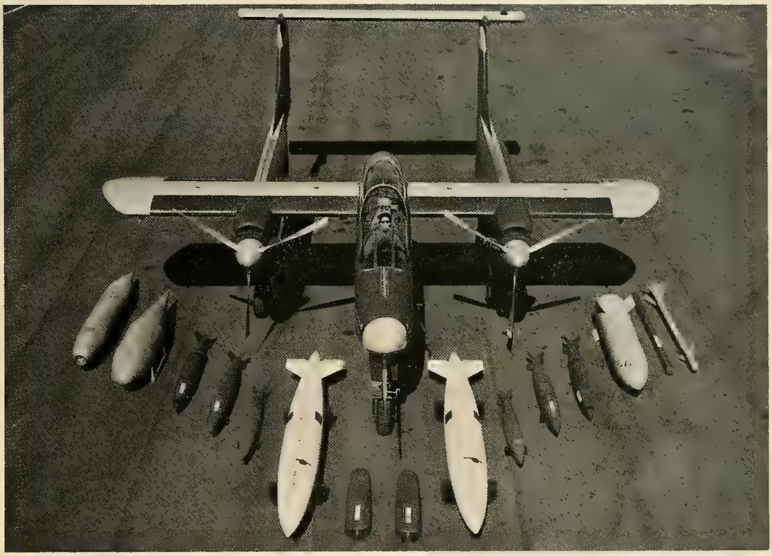
Once the tankage ratio control is corrected, the engines would then run at the P.U. control mixture ratio—probably 4.6:1. As the specific impulse of the engine increases with decreasing mixture ratio, "mixture-ratio profiling" results in improved vehicle trajectory performance, and therefore increased payload capability. The payload gain potential is about 23 lbs.

The *AC-6* P.U. system payload capability is approximately 30 lbs. less than the GD/Convair computer study showed. This results from ending P.U. control with about 4% of the propellants remaining. ■

Bowers Details Convair Market Aims

New General Dynamics division chief expects to turn sales upward with proven products; Atlas SLV regarded as mainstay

by Willard E. Wilks



DESPITE loss of only Charger counter-insurgency aircraft, Convair planners see the light-armament reconnaissance plane as an important future program.

SAN DIEGO, CALIF.—Jack Bowers rose to his first crisis as head of General Dynamics/Convair last week when the division's newest pride, the Charger light-armed reconnaissance aircraft, was totally wrecked in San Diego, Calif.

Talking with MISSILES AND ROCKETS shortly after receiving the news that a landing accident had destroyed the only Charger flight model, he refused to alter a statement he had made in an M/R interview the previous day to the effect that the Charger was important to Convair's future.

"The statement stands," he said.

That out of the way, he continued with a detailed explanation of how he expects to turn division sales upward again, following their drop from the peak achieved during the *Atlas* missile and booster program.

In his first interview since his elevation to general manager last month, Bowers told M/R that his battle plan calls for exploitation of proven products and capabilities with a lean, flexible outfit. He sees no new "basic product directions" ahead for the division over the next 5 years and plans to build on existing "baseline" products and technology.

"My charter instructions are to do everything I can to provide a profitable future," he said. "There are no indications that I should change direction or specifically modify any existing plans," he added, quashing industry rumors that he might effect some significant product changes.

- **Study under way**—Bowers currently is engaged in a thorough analysis of the division, which centers its activities in two locations—Lindbergh Field and Kearney Mesa—in San Diego. He explained, however, that this undertaking is not a result of the recent appointment but is necessitated by the fact that the company's fiscal year starts Jan. 1.

"After we have properly analyzed what our facilities and technical abilities are, we will . . . take those actions necessary to assure a profitable future and improve service to the customer," he said.

Bowers rates as his most important immediate goal the establishment of a low-cost, effective operation. "We plan no arbitrary cuts, but will on a continuing basis look at the minimum cost approach consistent with doing a good job, and if this analysis shows that certain activities can be eliminated or combined with others, it will be done."

Employment currently is in the neighborhood of 14,000, including personnel at relatively small activities outside San Diego. At present, a few minor cuts are under way, but Bowers, asked what the employment level might be 1 or 2 years from now, answered this way:

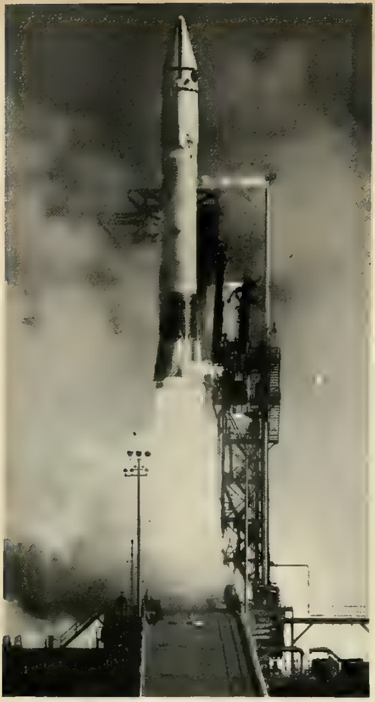
"Always, in this business, it (employment) is dependent on the success of the business that is being pursued right now. The main management approach I think has to be used is to pursue very hard those things that will be expanding in the future, and then conduct business at proper employment levels. We need flexibility.

"I like always to have existing plans so we can operate at a percentage above or below that level—without major modifications in our way of doing business. The employment level is entirely dependent upon the success of certain programs we are pursuing now."

- **Gradual expansion**—Following the setting up of a low-cost, effective operation, Bowers' plans call for "gradually evolving from the technical capabilities that have existed here through the aircraft years and the *Atlas* missile program into a properly rounded, full systems capability. I certainly haven't established any need for major changes in directions yet and have launched no programs."

At present, Bowers said, he is concentrating on those things that are in hand and which are capable of extension.

"First is the Standard Launch Vehicle (SLV)—*Atlas*. We feel this will have application extending at least through the next 10 years. We are constantly evaluating its application to various Air Force and NASA missions and seeking means of assuring its con-



ATLAS-CENTAUR shown at liftoff. Both the Atlas SLV and the Centaur upper stage are expected to have 10-year usefulness.

tinued reliability and increasing its performance. Our ability to do this will determine how far in that 10-year period or beyond the SLV will be an important program.

"Another important program is *Centaur*. This has recently firmly established itself on an operational basis and applications for this vehicle go well beyond the 10-year period. Again, we are continually seeking means of maintaining reliability and upgrading performance.

"I should also mention that we have in production several satellite experiments which evolved into a vehicle known as *OV-1*, which has the potential of providing a continuing variety of experiments that can be accomplished when boosted by *Atlas* or other vehicles."

- **Other areas**—"On the airplane side, we have made our first sales of the Model 600 Dart engine conversion of the 240 and 340 Convair liner series. We intend to continue this program for the next several years, modifying existing equipment in the hands of operators who require efficient short-hop capability. We feel this will give them the best economical performance of any other alternatives available to them. On the C-141, we have done an effective job as subcontractor to Lockheed for the empennage, and follow-on orders are expected, and we hope to do similar business on the C-5A.

"In other areas, we have established a number of capabilities relating to systems management and including installation and operation of ground support systems and have continuing contracts of that variety.

"In connection with serving our past prime programs and conducting modifications to them, we have a capability of generalized aircraft and other modification work."

Bowers refers to these as the "baseline" programs, providing the basis for new business themselves while serving as springboards for growth.

As far as new product possibilities in the near-term are concerned, Bowers lists two—the Charger, which Convair built with its own funds for COIN competition, and the work being done on ducted-fan vehicles. "The more important of these is the Charger, which has been in flight evaluation by military pilots, and we expect it can very soon become important to our future."

In the ducted-fan vehicle area, Convair has been working for some time with a system originally known as LALO, for low-altitude observation, which was proposed for battlefield observation. Resembling a huge can with a fan in the bottom, the vehicle may even be capable of weapons delivery.

"We have a program with the Army in the unmanned ducted-fan configuration, with which we expect to proceed very shortly, and we are also looking at possible Navy application," Bowers said. "We feel we are about to kick off on the first application, and then there will be others. We have continued the conceptual development, modifying the configuration to make it suitable for specific applications."

- **Oceanic prospects**—A program that so far is only minor in nature, but which Bowers feels could be listed as a "baseline" system, is work done in developing oceanographic buoy systems. Under a Navy program, a tethered buoy designed to radio weather and ocean-state conditions has been tested off the East Coast.

"Of particular interest is the fact that the station off Florida rode out the recent hurricane very well, continuing to report all information through the entire period," Bowers reported. "The concept is that one day we may have big networks of these spread over all of the oceans for better data coverage than exists now. We are proving the systems, both the buoy and its sensors."

At the same time, he points out that General Dynamics looks with a great deal of optimism on the possibilities of expanding ocean use, surface and sub-

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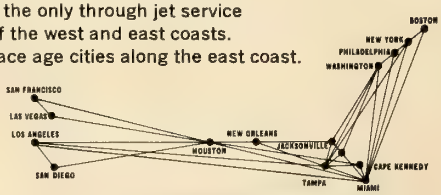

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surface, and that many GD divisions are expanding activities in oceanology.

• **Future studies**—Looking further ahead, Bowers says: "Mainly, we feel that the total of manned and unmanned space activities we have now are going to be a significant feature of our operations here. We are interested in continuing to improve and round out our total systems capability in order to compete in these kinds of product areas.

"These things extend all the way from boosters to upper-stage vehicles to instrumented payloads and mission analysis and operations. Sometime in the future, there will be a need for reusable boosters and upper stages. We feel that sufficient technology exists so that this program should receive immediate attention."

The division has under way a new area of studies on a very broad basis for NASA, including post-*Apollo* manned space activities and vehicle payload requirements and space probes in the unmanned area.

Work also includes study of a kick stage which could be used with *Centaur* and other upper-stage vehicles, and an advanced engine concept. The latter, funded by NASA for several years, is for hardware demonstration of a low-thrust, very-high-efficiency electric engine.

In-house funded work includes life sciences investigation keyed back to manned space programs, space physics study, advanced materials research applying to both manned and unmanned programs and advanced ICBM study.

At company expense, Convair recently completed an integrated manned mission space simulator which gives the division the ability to evaluate various control techniques for space missions. This is in addition to a manned free-space simulator with six degrees of freedom to evaluate zero-g physical tasks.

• **Electronics**—Convair also expects to continue its work and growth in certain electronic areas, but not in any unusual way. Bowers, who holds an electrical engineering degree and has bossed electronics both for GD and Avco Corp., says, "just because I'm here now is no reason to speculate that there will be any increased emphasis in electronics. However, people should realize that in an all modern aircraft and space activities, electronics has a very important role, and I believe I can say that our systems divisions have 30 to 70% involved in electronics across the board." He points out that his executive background includes work in areas besides electronics.

Noting that Convair provided the antennas for the *Apollo* instrumentation ships when that contract was won by another GD division, Bowers said that combining capabilities of its various divisions has become "the order of the day" in GD to achieve the maximum competitive position.

• **Being competitive**—Summing up, Bowers reiterated that the most important immediate and continuing goal of the division will be "making ourselves more and more competitive in dollar cost. For example, I don't think we will be able to obtain a supporting role on C5A unless we are really competitive. And in production of boosters —if we don't continue in reducing cost, someone else will move in."

With regard to Convair's competitive position, Bowers said it was felt the division recently achieved "a very good first need in establishing our recent agreement with labor. That has given us a five-year stable work force. It gave us a very competitive cost figure while providing the union with many advantages they had been looking for. I feel we have jointly achieved one of the most satisfactory mutual agreements accomplished in this or any other industry." ■

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MSC Initiates Design Of Two-Gas AA System

by Heather M. David

St. Louis—NASA's Manned Spacecraft Center has begun the design phase of hardware for a two-gas life-support system for the *Apollo* Applications (AA) spacecraft.

The design contract, estimated at about $750,000 and held by Garrett Corp.'s AiResearch Mfg. Co., is aimed at providing a system capable of sustaining the life of the crew for orbital missions up to 45 days. A major objective, MSC's Crew Systems Division chief Dick Johnston told Missiles and Rockets, is to make use of existing *Apollo* hardware, effecting only those modifications necessary to extend the lifetime.

One of the major decisions NASA must face in the next few months is whether to use nitrogen or helium as a diluent gas in the AA atmosphere. It will be the first manned NASA vehicle to have a two-gas system, if it is definitely decided to depart from the 100% oxygen, 5-psia atmosphere used in *Mercury, Gemini,* and the basic *Apollo.* Fear of possible oxygen toxicity problems during long-duration missions is behind the switch to a two-gas system.

While nitrogen is understood to be favored by Manned Spacecraft Center officials at the present time, some engineering studies show that advantages might accrue from the use of helium. The whole question of helium vs. nitrogen was fully discussed recently at a special meeting of the American Institute of Aeronautics and Astronautics and the Aerospace Medical Association held here. The debate underscored the fact that the question of spacecraft atmosphere for both *Apollo* Applications and the Air Force's *Manned Orbiting Laboratory* must be resolved during the next few months.

- **Apollo system**—Johnston said one of the major changes to be made in the life-support system, to enable it to function for 45 days, is the replacement of the lithium hydroxide canisters used for removing carbon dioxide with a molecular sieve.

The system probably will be heat-desorbed, Johnston indicated, and the CO_2 will be dumped overboard. There will be no attempt at collecting the CO_2 for recovery of oxygen.

The equipment which removes moisture from the cabin atmosphere through a wicking process and water separator probably will be sufficient even during the longer period, Johnston indicated. It has been demonstrated, especially in latter *Gemini* flights, that metabolic expenditures have not been as great as expected. While a special *Apollo* humidity-control subsystem has been developed for NASA by AiResearch, present experience indicates that humidity will not be a problem and special equipment need not be installed.

A trace-contaminant device is under contract with Lockheed Missiles and Space Co. for the *Apollo* program (M/R, Sept. 13, p. 26) and will be installed if the need for it is demonstrated. North American Aviation and the Air Force at Wright-Patterson AFB are doing toxicology work on *Apollo* materials.

- **Testing**—Life cycle tests are now being run on some of the pumps in the life-support system to see whether they will perform reliably throughout the longer mission.

A problem area, Johnston indicated, is the operation of oxygen partial-pressure sensors for the period. While some under development appear to have promise, it has not yet been proven that one can be run for 45 days. In addition, Johnston said, they do not have a very long shelf life.

- **New sensory techniques**—One of the theoretical advantages of helium, according to John Mason of AiResearch, is that sensory equipment for controlling the two-gas atmosphere could be simplified with the use of helium instead of nitrogen. Mason spoke for the engineering advantages of helium in the AIAA/ASMA meeting. Other panelists spoke for the advantages of nitrogen at the session, which was the first such planned debate on a scientific problem in the space program.

Mason said that 50-100 lbs. of all-up mission weight in an orbital vehicle could be saved with the use of helium. While helium will require heavier tankage to store the supply, savings could be realized in pumping equipment and in the controls area.

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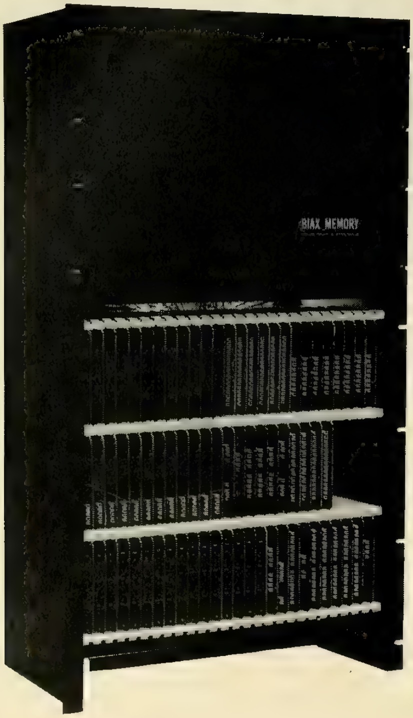

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molecular weight of oxygen and helium opens up a simplification of the problem, he said. Since nitrogen and oxygen are so much closer in molecular weight, there is no advantage in that combination.

Johnston also suggested that a control system might be designed in which the thermal conductivity of the gas stream could be measured to calculate the percentage of helium, and a simple total pressure sensor used to obtain the partial pressure of oxygen and the total pressure.

Mason said that he based his assumption of a weight savings in pumping power on the premise that because of helium's thermal conductivity characteristics, crewmen could endure a higher operating temperature.

Douglas Missile and Space Systems Division's Terry C. Secord, leader of a group which has recently completed a 20-day oxygen-helium manned space-cabin simulation (M/R, June 28, p. 38), said these tests indicated thermal comfort curves ran at much higher temperatures in the helium mixture than in an earlier nitrogen/oxygen run.

Mason added that his studies showed that while some engineers had feared excessive cabin leakage with helium, this would not be the case and that helium in fact compares well with nitrogen in that respect.

- **Physiological arguments**—Dr. John Billingham, formerly with the Manned Spacecraft Center and now of NASA's Ames Research Center, said that he felt that in the absence of real advantages in favor of helium, the more familiar and understood nitrogen should be used.

He said that there is strong evidence that some organisms are influenced by helium, and he cited one case of apparent effects on the central nervous system in a very short exposure.

Dr. Emanuel Roth, scientist from the Lovelace Foundation who has been conducting a survey of literature on various space cabin atmospheres for NASA, presented data which actually showed that neon would be the best choice, based upon a number of criteria including fire hazard and decompression sickness.

Douglas scientists said that during their decompression simulations, conducted during the recent 20-day helium/oxygen test, they had no problems with "bends."

However, Dr. Thomas Allen, chief of the Air Force's Physiology Branch at the School of Aerospace Medicine, told the meeting that his research with large numbers of men shows that bends can be produced from a helium/oxygen environment as easily as from a nitrogen/oxygen atmosphere. (M/R October 18, p. 29). ■

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The Industry Week

Mergers and Acquisitions

Ling-Temco-Vought, Inc., Dallas, has agreed to purchase for cash the assets of Okenite Co., a Passaic, N.J., subsidiary of Kennecott Copper Corp. Okenite makes and sells high-voltage cable. The acquisition, estimated to have cost $30 million, is intended to improve LTV's ratio of commercial to defense business. Target date for concluding the deal is late November. The transaction is subject to approval of the Federal District Court of New York, which ordered Kennecott to divest itself of Okenite in an anti-trust ruling last year. . . . *Sanders Associates, Inc., Nashua, N.H., is exploring the possible acquisition of Advanced Development Laboratories, Inc., also in Nashua. The transaction being considered would call for Sanders to acquire substantially all assets of ADL for shares of Sanders class A common stock, probably at a ratio of one Sanders for 10 ADL.* . . . Western Equities, Houston scientific instrumentation concern, has purchased Metric Systems, Inc., Ft. Walton Beach, Fla., and Datamatics International, Inc., of Dallas. Metric Systems develops and manufactures electronic data handling systems and Datamatics designs and makes automated data acquisition and handling systems. . . . *Control Data Corp., Chicago, has completed acquisition of Howard Research Corp., Arlington, Va., for 77,400 shares of Control Data common stock with a market value of about $2.5 million. (M/R, Oct. 11, p. 41).* . . . Deering Milliken, Inc., a Spartanburg, S.C., textile company has acquired 51% of the voting stock of Chomerics, Inc., Plainville, Mass. Chomerics holds basic patents on metal-filled plastics with high electrical conductivity. The firm makes the plastics for use in RF shielding, microwave guide gasketing, and direct-current and RF grounding. Terms of the acquisition were not revealed.

New Activities

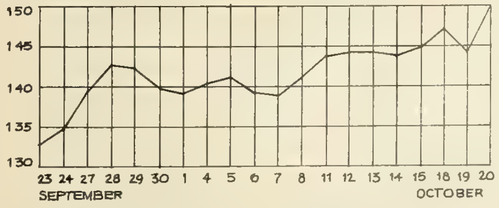
Aluminum Company of America, Pittsburgh, has announced plans for a multi-million-dollar expansion of forging facilities, primarily to provide new furnaces and auxiliary equipment essential to the fabrication of titanium. Work on the installation, to be installed adjacent to the company's Cleveland Works, is scheduled to begin before the end of the year, and commercial production of large titanium forgings is expected to be underway by mid-1967. . . . *URS Corp. has established the California Systems Center in Burlingame, Calif., to perform electronic data processing, operations research and related computer services for clients on the West Coast.* . . . Isochem, Inc., New York City, a joint subsidiary of Martin Marietta Corp. and U.S. Rubber Co., has signed a contract to operate the chemical processing department of the Atomic Energy Commission's Hanford (Wash.) Works. A 5-year contract calls for transfer of the chemical processing department to Isochem from General Electric Co. effective Dec. 31 and construction by Isochem of an $8-million plant. . . . *Recognition Equipment, Inc., Dallas, manufacturers of optical character recognition and systems for use with large-scale electronic data processing or automatic typesetting systems, has opened a regional office in Washington, D.C.* . . . The Sierracin Corp., Sylmar, Calif., has added four scientists from North American Aviation's Rocketdyne Div. and Northrop Corp.'s Norair Div. to its research and development program to improve present product lines and develop new ones. Sierracin makes proprietary products, principally flight safety systems for the aerospace industry.

Facility Expansions

The Boeing Co. on Oct. 19 unveiled its new Space Center near Kent, Wash. Four major laboratories, Space Environment Simulation, Space Flight Simulation, Materials and Process, and Microelectronics, are now in operation at the 320-acre site. The most recent addition is a two-story office building now under construction for the company's Space Div. . . . *Space Ordnance Systems, Inc., El Segundo Calif., plans to construct a 6,000-sq.-ft. headquarters building adjacent to four existing facilities. The expansion is said to be necessary to handle new orders for electro-explosive systems and propellant-activated devices and systems. Space Ordnance has just been qualified as an approved source for the Apollo standard initiator.* . . . The Perkin-Elmer Corp., in Wilton, Conn., has agreed to purchase the land and plant presently occupied by the Manson Laboratories Div. of the Hallicrafters Co. The additional facilities will be used to meet expanding business of Perkin-Elmer's present Electro-Optical Group in Wilton.

Missile/Space Stock Index

The Missile/Space Stock Index rode the crest of an industrial upsurge and neared the mark that would signify a 50% increase in the value of the 19 representative stocks since Jan. 1. Huge airline orders, promises of a large supplemental defense request in January, and the injection of considerably more money into the whole aerospace group with the C-5A contract and subcontracts, brought about the increase.



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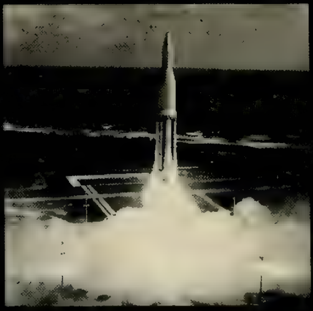

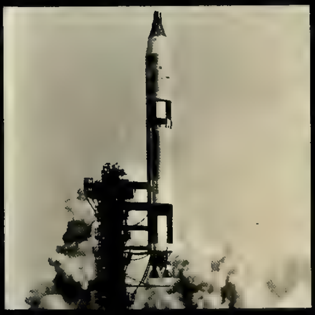

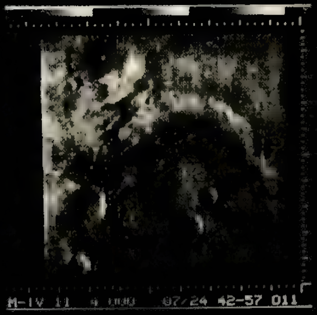
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This special issue will also explore NASA's plans for other new projects as the U.S. space program begins its swing away from the exploration of the Moon to the vaster and more challenging mission of probing the planets.

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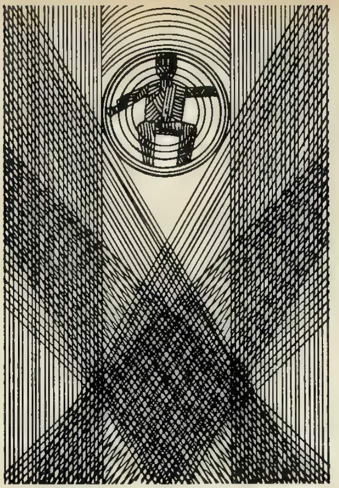

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$27,320,199—**Douglas Aircraft Co., Inc.**, Tulsa, Okla., Electronic Systems Div., Hanscom Field, Mass., for modification of C-135 aircraft in support of the NASA *Apollo* program.

$8,055,600—**Martin Marietta Corp.**, Friendship International Airport, Md., for work on *Titan II* intercontinental missiles and related equipment at Littleton, Colo.

$3,300,000—**Sylvania Electric Products**, New York, N.Y., from the Aeronautical Systems Div., for advanced airborne equipment components and spare parts.

$3,210,525—**Continental Aviation and Engineering Corp.**, Toledo, Ohio, for J-69 engines for target drone aircraft.

$3,000,000—**Douglas Aircraft Co.**, Santa Monica, Calif., the first increment of a $15-million contract to build space boosters.

$2,611,858—**Fairchild Hiller**, Republic Aviation Corp. Div., Hagerstown, Md., for production of rocket catapults for aircraft ejection seats.

$1,400,000—**FMC Corp.**, New York, N.Y., for production of unsymmetrical dimethylhydrazine (UDMH), a synthetic liquid rocket fuel.

$1,310,000—**Babcock Electronics Corp.**, Costa Mesa, Calif., for production of an electronic system to measure misses by missiles.

$1,100,000—**Collins Rado Co.**, Dallas, Tex., to provide maintenance and training for communication and navigation equipment.

$1,085,000—**Avco-Everett Research Lab.**, Everett, Mass., for analytical and experimental studies of the flow fields and wakes of re-entry vehicles.

$1,000,000—**Sylvania Electric Products, Inc.**, New York, N.Y., increment to an existing contract to make communications equipment in Waltham, Mass. and Buffalo, N.Y., for *Minuteman* missile operations.

$700,000—**Raytheon Co.**, Lexington, Mass., from Arnold Engineering Development Center, Tenn., for two digital data processing and control systems.

$481,325—**Radio Corp. of America**, Missile & Surface Radar Div., Moorestown, N.J., for engineering and logistic services to be performed in connection with the BMEWS program.

$74,986—**Ohio State University**, Research Foundation, Columbus, Ohio, for investigation to solve the direct scattering problem for bodies of arbitrary size and shape.

ITT Corp., Federal Laboratories, Nutley, N.J., for experiments and mathematical studies to determine exactly what happens to a laser beam as it passes through the atmosphere. (Amount not disclosed).

ARMY

$7,175,000—**Radiation Incorporated**, Melbourne, Fla., from Satellite Communication Agency (SATCOM), Ft. Monmouth, N.J., a two year pact for transportable AN/TSC-54 communications terminals.

$2,198,500—**General Dynamics**, Convair Div., San Diego, Calif., from the Canaveral district of Army Corps of Engineers, to design and install a broadcast-quality television system at the Kennedy Space Center, Merritt Island, Fla., launch complex that will be used for U.S. manned lunar flights.

$1,238,214—**Western Electric Co.**, Winston-Salem, N.C., from Army Missile command, Redstone Aresenal, Ala., to cover technical publications for the *Nike-Hercules*. Also $256,925 to **Douglas Aircraft Co.**, Charlotte, N.C., for the same.

$1,140,000—**Babcock Electronics Corp.**, Costa Mesa, Calif., for control systems for missile targets.

$820,547—**Belock Instrument Co.**, College Point, N.Y., from Army Missile Command, Redstone Arsenal, Ala., for engineering services and service documentation for the *Hawk* missile simulator trainer.

$704,207—**Martin Co.**, Baltimore, for *Pershing* missile components.

$698,610—**North American Aviation, Inc.**, Columbus Div., El Segundo, Calif., for flight services near El Paso, Tex., and engineering services at Columbus, Ohio, for the *Roadrunner* target missile.

$175,000—**Philco Corp.**, Western Development Laboratories Div., to design, develop and install a Satellite Communications Control Facility (SCCF).

NAVY

$14,000,000—**Hughes Aircraft Co.**, Culver City, Calif., to continue work on *Phoenix* missile systems.

$2,037,750—**Applied Science Industries, Inc.**, Falls Church, Va., Ships Parts Control Center, Mechanicsburg, Pa., for production of rocket components for use with the *Mighty Mouse* air-to-ground rocket.

$1,840,000—**North American Aviation, Inc.**, El Segundo, Calif., to make gyroscopes.

$292,884—**Radio Corp. of America**, Communications Systems Div., Camden, N.J., an increase on contract for the AN/ARC-104 program.

$150,000—**Sylvania Electric Products, Inc.**, Needham, Mass., for a miniaturized magnetic tape system to be used on ASW aircraft to store data from radar, sonar and sonobuoy devices.

NASA

$16,000,000—**Thiokol Chemical Corp.**, Reaction Motors Div., Denville, N.J., to develop a small 100-lb.-thrust rocket engine.

$4,000,000—**Telecomputing Services, Inc.**, Los Angeles, Calif., two-year contract for computer operations and data-processing services at the Goddard Space Flight Center, Greenbelt, Md. An option for an additional year would add $2 million.

$3,000,000—**Lockheed Aircraft Corp. Div.**, Burbank, Calif., to perform computer, programing and operations-support services at the Manned Spacecraft Center in Houston.

$2,000,000—**Radio Corp. of America**, West Coast Div., Van Nuys, Calif., increases for the *Saturn* Computer program.

$256,186—**Northrop Corp.**, Hawthorne, Calif., from Flight Research Center, Edwards, Calif., for lifting body research vehicle program R&D support.

$221,762—**Teledyne Systems Co.**, Los Angeles, from Flight Research Center for pulse code modulating systems.

$174,100—**David Clark Co.**, Worcester, Mass., from Manned Spacecraft Center, Houston, for *Gemini* G-4C suits.

$78,317—**Dynatronics, Inc.**, Orlando, Fla., from Flight Research Center for constant bandwidth telemetry system.

$70,000—**Kaiser Industries**, Kaiser Engineers, Oakland, Calif., from Manned Space Center for a feasibility study for expansion of mission control center.

$65,912—**Field Emission Corp.**, McMinnville, Ore., from NASA Headquarters for research study on cold field emission phenomenon.

$51,000—**TRW, Inc.**, TRW Structures Div., Cleveland, from Western Operations Office for large booster nozzle reuse study. Also Systems Group, Redondo Beach, Calif., $138,500 from Manned Spacecraft Center for ablative rocket empire components.

$38,700—**Hughes Aircraft Co.**, Ground Systems Group, Fullerton, Calif., from Manned Spacecraft Center for polarization of *Apollo* components.

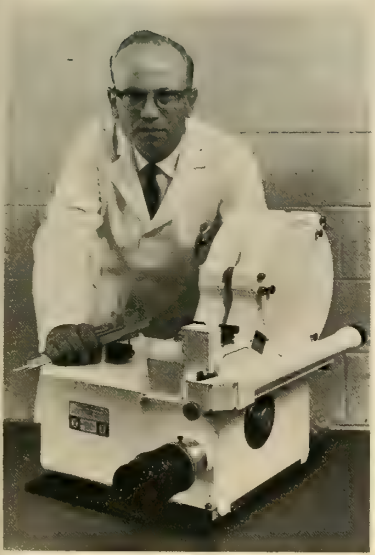
$38,700—**Franklin Institute**, Philadelphia, Pa., from Manned Spacecraft Center for *Apollo* initiator resistance measuring units.

INDUSTRY

$10,000,000—**Radio Corp. of America**, Communications Systems Div., Camden, N.J., by **Boeing Co.**, *Seattle*, to supply equipment for the modernization of the Air Force *Minuteman* missile system.

$808,000—**Epsco, Inc.**, Westwood, Mass., in two subcontracts from **North American Aviation Autonetics Div.**, for signal conditioning modules to be used in the *Apollo* capsule.

New Product of the Week: High-Speed Movie Camera



A 35-mm intermittent pulldown camera, designed primarily for photographing such activities as in-flight missiles, ordnance performances, parachute drops and airplane tests, has been announced by Giannini Scientific Corp.

The Model 705 Multidata® camera photographs at speeds up to 300 frames per second and provides sharp, detailed photographs by use of vibration-free mechanisms, the firm says. Epicyclic movement is dynamically balanced to vibration levels below 0.0001 double amplitudes measured at the aperture.

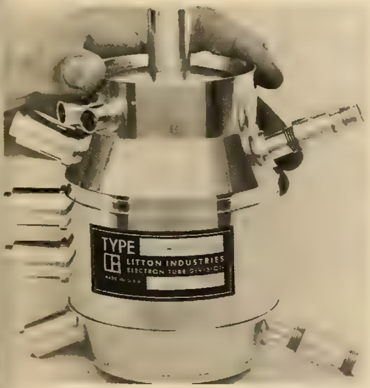
Speed range of the instrument is 3 to 300 frames per second, provided by a silicon-controlled rectifier motor speed control. Other features include ability to dial in the desired frame rate and the capability of changing speed remotely or during a film run, the firm points out.

Circle No. 151 on Subscriber Service Card

Klystron Amplifier

An electrostatically focused klystron amplifier—specifically designed for use in advanced space communications systems—is being marketed by Electron Tube Div. of Litton Industries, Inc.

The Model L-5044 has an RF output power of 100 watts CW and 30-db gain. Efficiency is 35%. Nominal beam voltage is 2,700v; nominal beam current of 104 ma. Saturated gain is 20 db for a 3-db bandwidth of 6 mc and 30 db for a bandwidth of 5 mc.



Circle No. 152 on Subscriber Service Card

Portable X-Ray

A portable X-ray unit featuring a high penetration/weight ratio has been introduced by Balteau Electric Corp.

The Baltograph 300/2 is capable of penetrating steel up to 2.5 in. thick using lead screens and 4 in. thick with calcium tungstate screens. The complete X-ray head weighs 149 lbs. The unit is rated at 300 kv, 3 ma, with self-rectified circuitry.

The X-ray device is available in two models: Model P with 360-degree circumferential and Model D with single beam. Model P offers a focal spot size of 1.5 x 5.0 mm in central beam; the Model D, 2.3 x 2.3 mm.

Circle No. 153 on Subscriber Service Card

High-Temperature Alloy

A high-temperature alloy, developed for use in applications where temperatures to 1,400°F are encountered, has been announced by Crucible Steel Co.

The alloy, designated CG-27, is an iron/nickel-base alloy. It is forgeable, machinable in all conditions and weldable by the inert gas shielded-arc method. The product is available in billets, bars and wire.

Circle No. 154 on Subscriber Service Card

Spectrophotometer

A grating ultraviolet spectrophotometer, the Model DB-G, is being marketed by Scientific and Process Instruments Div. of Beckman Instruments, Inc.

The device is a double-beam instrument for making transmittance and absorbance measurements in the 190-700-mu wavelength range. With attachment of a red-sensitive photomultiplier, the range may be extended to 800 mu. The unit has resolution of 0.2 mu at all wavelengths and accuracy of better than 0.5 mu. The grating monochromator provides constant dispersion, which permits scans to be performed at constant resolution.

Circle No. 155 on Subscriber Service Card

Test Chamber

A thermal vacuum test chamber, designed to simulate up to 1.1 million feet of altitude, is being marketed by Tenney Engineering, Inc.

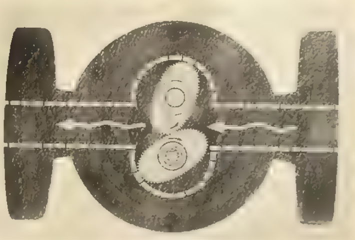
The mechanically refrigerated unit has a standard temperature range of −100° to 350°F, controllable to within ±1°F. An optional shroud provides −320°F. Vacuum of about 3 x 10^{-6} torr is reached in 2 hours with a mechanically refrigerated cold trap; a liquid nitrogen cold trap provides 7.5 x 10^{-8} torr.

Circle No. 156 on Subscriber Service Card

Displacement Flow Meter

A positive displacement flow meter, designed to measure rates from 0.005 to 3,000 gpm, is being marketed by Emerson Electric Co.'s Brooks Instrument Div.

The device is available in a variety of alloys capable of handling most corrosive reagents as well as standard liquids and materials such as liquified petroleum gas and monomers. The unit is constructed of two gears that rotate under extremely small pressure differentials passing a precise volume of liquid on each revolution. Standard accuracy is ± 0.5% of total flow.



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missiles and rockets

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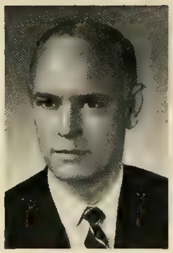
KENNEDY

McCORMACK

ADAMS

Loren A. Murphy: Elected president of Goodyear Aerospace Corp. He has been with the company for 40 years. **J. A. Keenan** has been named manager of manufacturing and will assume certain of Murphy's previous vice presidential responsibilities.

Donald G. Kennedy: Appointed manager of the Altair program at the eastern operation of Sylvania Electronic Systems.

James McCormack: Elected chairman and chief executive officer and chairman of the board of the Communications Satellite Corp. He is vice president of the Massachusetts Institute of Technology and chairman of the Massachusetts Bay Transportation Authority.

Dr. Mac C. Adams: Appointed NASA Associate Administrator, Office of Advanced Research and Technology. Adams was formerly vice president and general manager for space systems at Avco Corp.

Jackson R. Stalder: Named Chief Scientist of the Air Force Flight Dynamics Lab., Wright-Patterson Air Force Base, Ohio. He was one of four founders of the Vidya Research Company in 1958.

Dr. Edward Fryer: Named general manager of the Quantum Electronics Div. of the Varian Instrument Group. Dr. Fryer was previously a professor of physics at Pomona College.

Stephen Ailes: Elected to the board of directors of Nuclear Utility Services, Inc. He recently retired as Secretary of the Army.

William M. Weaver, Jr.: Elected to the board of directors of Tung-Sol Electric, Inc. He is chairman of the board of Howe Sound Co., and also director of the ITE Circuit Breaker Co.

Harry P. Smith Jr.: Appointed vice president in charge of video and instrumentation products of the Electronic Instrumentation Div. of Lear Siegler, Inc.

Kenneth R. Waltz and George E. Staley: Named vice presidents of American Avitron, Inc. Waltz was appointed vice president-sales, and Staley has been named vice president-manufacturing.

Arthur Asch: Elected vice president-sales of Kawecki Chemical Co. He will direct the firm's activities in the areas of marketing, sales and advertising for all divisions.

Joseph T. Laureno: Appointed to the position of purchasing agent at Lenkurt Electric Co., Inc. He will be responsible for the supervision and administration of all Lenkurt buying activities.

Albert W. Lawrence: Joined Uniform Tubes, Inc., as administrative engineer. He will be responsible for the development and supervision of practices and procedures of a rapidly expanding engineering department.

Elvet E. Moore: Appointed manager, defense microelectronics, of the Radio Corp. of America's Defense Electronic Products group. He succeeded **Ramon H. Aires,** who has been named chief engineer of RCA's West Coast Div.

W. R. Timken, Jr.: Appointed director-corporate development of the Timken Roller Bearing Co. He will be responsible for recommending to the president long-range plans covering the fields of market and product research.

Allan Q. Mowatt: Appointed vice president and general manager of Astrodyne, Inc. He has invented and developed devices widely used in the electronics industries.

Dr. Dan A. Brandt: Appointed director of engineering at Mechanical Products, Inc. He will have the responsibility of product and design engineering, research and development, and test engineering.

Thomas Keyes: Appointed SDS branch manager for the Dept. of Defense and intelligence systems. He joined SDS in 1963, moves up from Sales representative for the DOD and intelligence systems.

Bliss M. Bushman: Appointed vice president, marketing, of the SDS Data Systems, a subsidiary of Scientific Data Systems. He supervised the development and fabrication of the first multichannel high-speed analog-to-digital data acquisition system.

Ken P. Nagel: Promoted to vice president-area manager of Zurn Industries, Inc., Mechanical Power Transmission Div. He will take on increased administrative and marketing functions in addition to his operational field sales engineering activities.

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—when and where—

East Coast Conference on Aerospace and Navigational Electronics, sponsored by the National Professional Group on Aerospace and Navigational Electronics and the Baltimore Section of the Institute of Electrical and Electronic Engineers, Holiday Inn Downtown, Baltimore, Oct. 27-29.

Third Annual Conference on Energy Conversion and Storage, sponsored by Oklahoma State University School of Electrical Engineering, Stillwater, Oct. 28-29.

1965 International Space Electronics Symposium, sponsored by the Institute of Electrical and Electronics Engineers, Fontainebleau Hotel, Miami Beach, Fla., Nov. 2-4.

Seminar on "Determination of Physical Properties of Materials Through Sonic Resonant Methods," sponsored by Magnaflux Corp., Battelle Memorial Institute, Columbus Laboratories, Columbus, Ohio, Nov. 3-4.

National Security Industrial Association Research & Development Symposium, Department of State main auditorium, Washington, D.C., Nov. 3-4.

1965 Space Fair, sponsored by the Navy, Pacific Missile Range Headquarters, Point Mugu, Calif., Nov. 6-7.

1965 Winter Annual Meeting of the American Society of Mechanical Engineers, Chicago, Nov. 7-12.

American Society for Quality Control 1965 Aircraft & Missile Division Conference, sponsored by Cape Canaveral Section, A.S.Q.C., Ramada Inn, Cocoa Beach, Fla., Nov. 8-10.

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Circle No. 10 on Subscriber Service Card

Big-Solid Insurance Needed

TWO SOLID 120-INCH strap-on boosters hurtled an Air Force *Titan III-C* aloft on Oct. 15 to impressively demonstrate for the second successive time the reliability and performance of solids in this role.

The unfortunate fragmenting of the vehicle's Transtage after reaching orbit should not be allowed to obscure the fact that the United Technology Center solid strap-ons performed flawlessly, just as they did in the initial *Titan III-C* launch on June 18.

Less than a month earlier, Aerojet-General Corp. chalked up another major achievement in the field of big solids with the successful firing of the 260-inch SL-1 motor at its Dade County facility.

It is a sad state of affairs that, despite the success and promise of these recent events, the future of large solids remains in doubt.

The *Titan III-C* program, particularly with initiation of the *Manned Orbiting Laboratory* project, provides for continued activity with the 120-inch motors. But the picture is much darker for the 156-inch and 260-inch solids program. Aerojet has one more firing scheduled for the 260-inch motor, and that is the end of the line insofar as current funding is involved.

Meanwhile, the 156-inch military program is in the same sort of difficulty. Both Lockheed Propulsion Co. and Thiokol Chemical Corp. will have completed all firings in that program by early 1966.

As things now stand, there is no money in the Fiscal 1967 budget for the Air Force 156-inch project or the NASA 260-inch program. In each case, about $12 million would maintain momentum.

Is there a potential requirement for such motors?

Only last week, Gen. Bernard A. Schriever, head of Air Force Systems Command, was talking about 60- and 90-day missions for *MOL*. These could require the 156-inch solid strap-on to the *Titan III* core. Gen. Schriever said that while no specific mission may exist for the 156-inch at the moment, "I am sure at some future date the 156-inch will be used."

NASA's A. O. Tischler, director of the Chemical Propulsion Div. of the Office of Advanced Research and Technology, outlined several potential roles for 260-inch motors in a briefing earlier this month. These depend on mission decisions still to be made in the field of planetary exploration. Unless we are to give up space exploration altogether after the lunar landing, it seems certain a NASA need will exist for the 260-inch solid motor.

The Administration, confronted by an expanding war in Viet-Nam and equipped with a desire to keep the Great Society on an even keel at home, is facing some difficult decisions on guns versus butter in drawing up the Fiscal '67 budget. In such a situation, it is all too easy to kill off promising research and development programs because the money spent offers no immediate dividend.

Exploration of technology provides no great attraction if it doesn't answer the immediate question, "Who needs it?" Yet such a short-sighted attitude can cripple programs not yet in existence. It is all too easy to forget that the booster technology of the *Apollo* lunar program was funded years ago. The F-1 engine is an adaptation of an *Atlas* missile engine and is based on technologies in hand long before NASA itself was in existence.

Tischler puts it well when he says, "Anything along the lines of propulsion has got to be aimed at some future requirement." Engines are a pacing item and failure to realize that can cripple future projects.

The half-length Aerojet 260-inch motor generated 3.5 million pounds of thrust. This is the largest single rocket motor ever fired. Each solid booster on the *Titan III-C* develops over 1.2 million pounds of thrust. These will be man-rated in the *MOL* program. The 156-inch motor fired by Thiokol last February delivered 3.2 million pounds of thrust.

LET'S TAKE A LOOK at some of the uses NASA might find for the 156-inch or 260-inch motors. Replacement of the first stage of *Saturn V* by a cluster of three 260-inch motors would uprate its capability from 240,000 pounds in orbit to 285,000 pounds in orbit, or even to 300,000 pounds. Use of a cluster of six 156-inch motors could accomplish much the same thing.

Such motors also could be used as strap-ons instead of replacements. Four 156-inch strap-ons to *Saturn V* would uprate it to 311,000 pounds in orbit. Two 260-inch strap-ons would increase the initial 240,000-pound capability to 427,000 pounds.

Four 260-inch strap-on motors would enable *Saturn V* to put 700,000 pounds in orbit. This would enable establishment of a large permanent station in orbit, useful for a number of Earth-oriented missions or as a starting point for manned planetary flight.

Tischler also has pointed out that development of a new hydrogen-oxygen core stage weighing some 31 million pounds to use with 260-inch strap-ons offers some truly staggering possibilities. The core stage and two strap-ons could lift a million-pound payload into orbit. Four strap-ons would increase this to 1.7 million pounds and with eight it would go to 2.4 million pounds in orbit.

Work at OART indicates that this booster, basically a simple two-stage launch vehicle, checks out as a relatively cheap system which, over 25 launches, might bring the cost per pound of payload in orbit down to $83.

Obviously, unless we are planning to set off on manned planetary exploration about then, such a massive booster would be senseless. But it is equally apparent that unless we push ahead with some of these advanced propulsion concepts right now, we will have no such options.

The relatively small amount of money Air Force and NASA would require to continue the 156-inch and 260-inch solid motor programs would be good insurance.

William J. Coughlin

With our traffic, we sometimes wonder what the neighbors will think.

Monkeys, astronauts, telescopes, sea urchin eggs and tradescantia come in the front door. Weather satellites, orbiting observatories, ballistic re-entry systems, manned orbiting labs, biosatellites, space taxis and space buses go out the back. Mark 2 and other vintage re-entry systems are in the Smithsonian (we're now developing advanced ballistic and return-from-orbit re-entry systems). Nimbus flew out of our Valley Forge space simulators a year ago and faced the world. At one extreme we built a 15-part Gravity Gradient Stabilization System which is still operating within 4½ degrees of arc. At the other, our 22,000 part control system for OAO will soon have its chance to hurtle a Mt. Palomar through space.

Biosatellite with its lively "crew" is slated for several round-trips soon. MOL and its astronauts will see the countdown a couple of years later (recently selected as a prime contractor). We're studying unmanned exploration of Mars (Voyager). Our SNAP 27 will be the first nuclear power system to hit the moon.

And we have a lot of ambitions that are yet ideas. Space shuttles and space station taxis, for example. No wonder our engineers always buckle down (their own test benches may go up next).

Are you interested in IR/optics, simulation, human factors, life support, radar discrimination, structures and weights, reliability, guidance & control, measurements and environments, materials development, spacecraft design, experiment integration and installation, structural mechanics, aerodynamics, thermodynamics, flight systems analysis, electrochemistry, flight mechanics, operations research, fluid mechanics, arming & fuzing, nuclear power (SNAP 27). Write to Mr. J. S. Barson, Dept. 394K-4, Space Technology Center, General Electric Co., P.O. Box 8555, Philadelphia, Pa.

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A recent breakthrough in materials for hardened heat shields will help ballistic vehicles penetrate harsh environments — ranging from the shock of radiation to fireball traverse.

Lockheed has developed a method of producing composite materials possessing thermal efficiency and structural strength superior to state-of-the-art approaches. It is based on winding and inorganically bonding various types of filaments such as carbon, silica and graphite.

The Lockheed composites offer many advantages. They are tailored to different environments through an interdisciplinary effort involving weapons effects, system design and other key technologies. Example: a gradual transition from carbon filaments on the surface of the shield to silica in the mid-portion increases strength, lowers thermal conductivity. Result: stronger, lighter hardened heat shields - and optimu vehicle design.

Materials such as these are just o measure of the technological co petence of Lockheed: a corporati dedicated to the conquest of ne worlds through innovation.

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NOVEMBER 1, 1965

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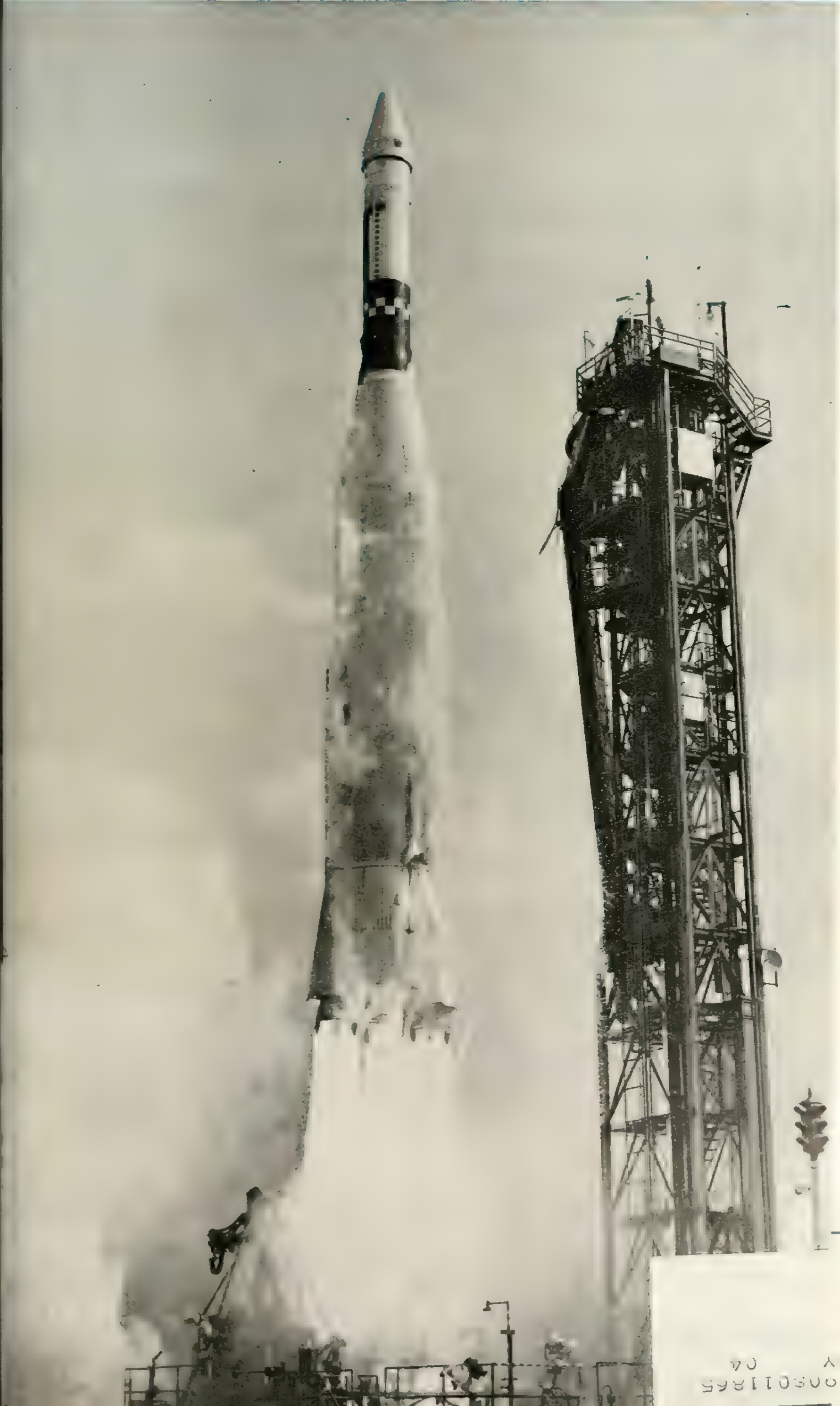

Rendezvous Flight Off Until 1966

New Air-Defense Missiles Pondered

Manned Apollo Speed-up Possible

Further Post-'70 Missions Studied

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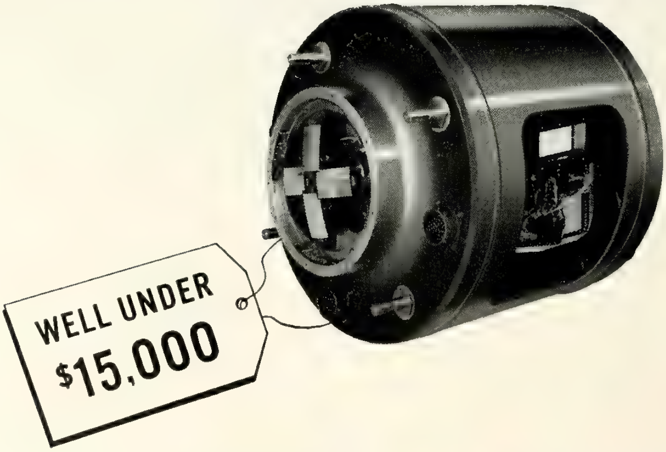

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THE WEEKLY OF ADVANCED TECHNOLOGY

Volume 17, Number 18 November 1, 1965

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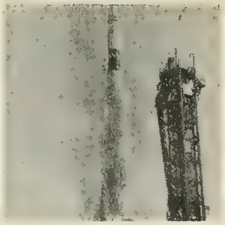
THE COVER



Atlas-Agena rises from Cape Kennedy in flawless launch phase of what was to have been the first rendezvous and docking of two objects in space. Agena, however, failed to orbit, and the GTA-6 flight of Astronauts Walter Schirra and Thomas Stafford was aborted. See p. 12.

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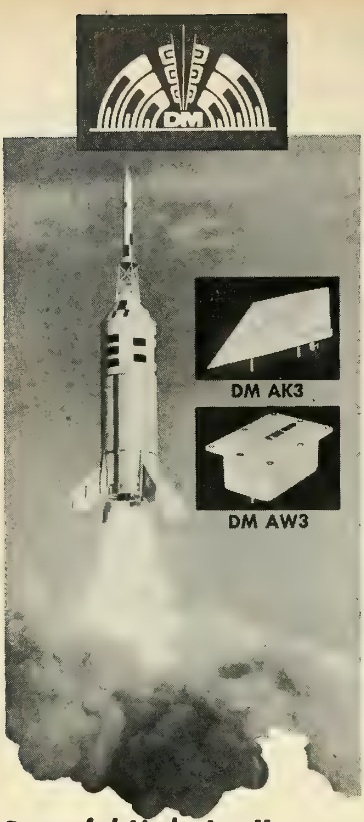

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letters

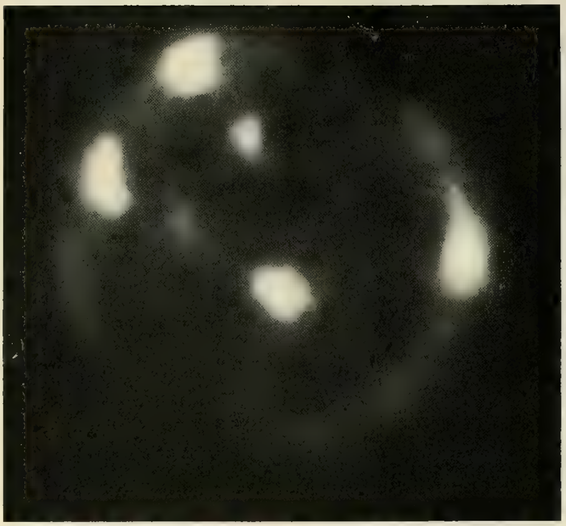
Solar X-Rays

To the Editor:

My attention has been drawn to a recent letter from Dr. George W. Clark (M/R, Aug. 2, p. 5.)

I feel I must come to the defense of the M/R reporter at the COSPAR meeting, who was quite correct in what he said about the solar X-ray images that I reported at the meeting. The full paper will be appearing shortly in "Space Research" Vol. 6, published by North-Holland, Amsterdam. At the meeting, I described X-ray photographs obtained in three *Skylark* flights of August and December 1964 and April 1965. I enclose a print of one solar image obtained in the December flight so that you may see there are indeed clear indications of X-ray condensations on the disc, limb brightening and polar darkening.

K. A. Pounds
Lecturer
The University
Leicester,
England



PHOTOGRAPH OBTAINED on Dec. 17, 1964, shows Sun in X-rays of wavelength 30-50 Å. u.

PR at Cross-Purposes

To the Editor:

One of our members has sent us a reprint of your editorial, "The Ugly American," from the Oct. 4 issue.

We were disturbed to learn about the events in Greece which appear to have been handled very poorly and with complete disregard of the basic principles of public relations as well as common courtesy and good manners.

We sincerely hope that your editorial had the good effect of making NASA aware of this bungling so that it will not occur again. This is a classic example of two groups working at cross-purposes—USIA is working diligently to let the rest of the world know what a good-neighbor nation the United States wants to be, yet the people involved in this affair in Greece are bound to have an opposite opinion.

This letter comes to tell you that while we naturally dislike to learn of situations like this, we at the same time believe that poor performance should be exposed when it occurs.

Quentin L. Harvell
Executive Director
Public Relations Society of America
New York, N.Y.

Orbits for Gemini

To the Editor:

It seems pertinent at this time to question the decision of certain NASA officials on their choice of method for defining and recording the multiple circumnavigation of the Earth by the *Gemini* spacecraft. The selection of "revolutions" as a measure of such circumnavigation—defined as the interval commencing at a given longitude and ending at the return to that longitude—I, and many others, think is inappropriate for the following reasons:

1. For as simple a case as circular orbits, each different altitude will represent a different number of degrees traveled to circumnavigate the Earth by definition of the term "revolution."
2. Well-established precedent is being broken, making comparisons needlessly difficult.
3. Measuring an orbit from one ascending node to the next ascending node is accurate, means the same thing independent of altitude, and has its roots in astronomy for hundreds of years.
4. The SPADATS tracking bulletins will continue to use *orbits.* Since these are incommensurate with *revolutions,* the press and other persons are thereby confused.
5. Since we are going to continue to compare our deeds with those of the Soviet Union, it is better to use orbits—as they continue to do; for instance, the press compared *Vostok 5* (81 orbits) with *Gemini 5* (121 revolutions), but *Gemini 5* actually completed *126* orbits. If we are going to race, let us get scored in comparable terms!

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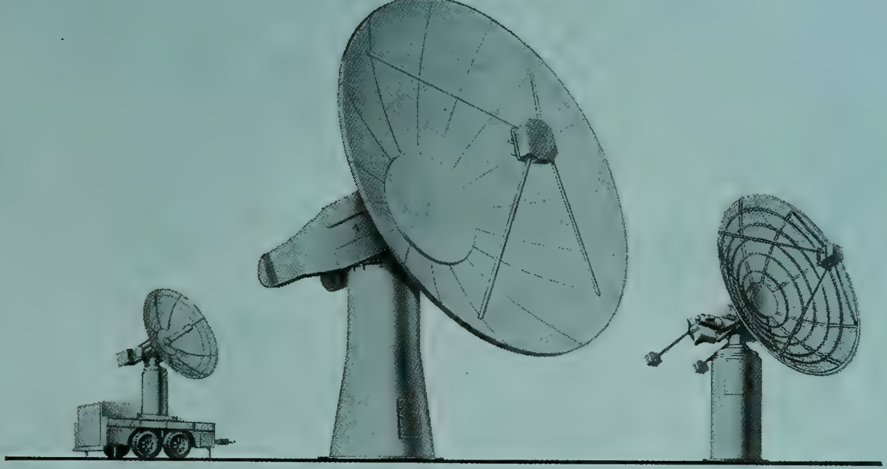

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The Countdown

WASHINGTON

Exit McNamara, Enter Vance?

On Oct. 1, Secretary of Defense Robert McNamara surpassed the mark of 4 years, 8 months and 11 days in that office set by the late Charles E. Wilson. It is not surprising, therefore, that rumors once again are cropping up about his possible departure from the Pentagon. Just last week, for example, a syndicated column reported that McNamara has told the President he plans to leave his position before the new Congress convenes in January. What is surprising to veteran Pentagon observers is the careful wording of some of the denials. They can be described as less than categoric.

Case of the Missing Agena

NASA opposed Air Force proposals that the modified *Agena* target vehicle be flight-tested before use in a *Gemini* mission for two reasons. One was a lack of money. The other, according to NASA officials, was the lack of any time-saving by such a test since the target vehicle launched was the first one ready for flight. This, however, overlooks *Agena* 5001. A flight vehicle, it has been sitting at Cape Kennedy, unmodified for the target mission, since its use in a "wet mock" test on July 22.

End of the Line for A-1 Missile

Arrival of the SSBN 602, the Abraham Lincoln, in New London, Conn., Oct. 23 to enter overhaul marks the end of deployment for the 1,200-mile-range *A-1* version of the *Polaris* missile. Since 1960, 29 SSBN's have been deployed. Five of these, the last to carry the *A-1* operationally, are now in overhaul being fitted with the 2,500-mile *A-3* missile. At completion of the current overhaul and the 41-ship building program, there will be 13 SSBN's carrying the 1,500-mile *A-2* and 28 boats carrying the *A-3*.

Strippers at Work in Viet-Nam

Chemical defoliation of Vietnamese jungle areas is now being carried out effectively and rapidly both from the ground and the air. New sprayers and a better understanding of chemicals, the amounts to apply, and the time of year to apply them, did the trick. Army reports say the Viet Cong now tend to leave an area as soon as spraying starts, apparently believing their own propaganda that the U.S. is using poison gas.

A Look at the Congressional Boxscore

In the last-minute rush before adjournment, the Senate passed the bill centralizing Government management of automatic data-processing equipment, thereby readying it for the President's signature. Left hanging in this session: A Senate bill on freedom of information, which withered in House committee, and bills to set a Government-wide patent policy, which never left the Senate.

More Heft for Choppers

Army has put into production a new armament system to beef-up the supressive fire capability of the HU-1B helicopter in Viet-Nam. Emerson Electric will produce the new system, tagged XM-21, in which a fixed seven-round rocket pod utilizing 2.75-in. aerial rockets will be mounted on each side of the helicopter. System also includes one General Electric 7.62-mm machine gun, capable of firing 6,000 rounds per minute.

NASA Plans LEM Radar Backup

NASA is planning to develop a backup method to the Lunar Excursion Module's radar system for use in controlling the manned landing on the Moon. Geonautics Inc. holds a contract for three prototypes of a binocular viewing device which the astronauts can use to measure spacecraft altitude above the lunar surface and the velocity relative to the surface during descent. These are to be delivered next February.

Army Cites Helicopter Losses

Despite substantial helicopter losses in Viet-Nam, the Army says they are less vulnerable than anticipated. Based on over 650,000 combat sorties, statistics show that a chopper will be hit by ground fire once in every 300 sorties, will be downed once in every 6,000 sorties, and will be lost to ground fire once every 12,000 sorties.

I'm Dreaming of A . . .

NASA will have to overcome the opposition of Navy Dept. officials if it wants to schedule the *Gemini 7* launch for the Dec. 7-8 period. They foresee a morale problem from the 14-day mission if men on the recovery ships can't get back to shore in time for Christmas.

INDUSTRY

Hughes Aircraft on the Move

Hughes Aircraft is dickering with Bunker-Ramo for lease of facility space at the latter's Canoga Park, Calif., headquarters, not an unusual event. Reaction of the Hughes public relations staff to queries about the move is so sensitive, however, that some observers believe there may be something bigger in the wind. "We are just in no position at all to talk about it right now," one Hughes spokesman says. "Reports of these things in print always cause problems. You know what happens to the price of land around there when that happens."

Teleprinter Sought for Space

NASA's Manned Spacecraft Center is asking industry to demonstrate a spacecraft teleprinter to be carried aboard long-duration *Apollo* missions. Request for Proposals, due Nov. 11, specifies a 280-cu.-in. chassis of not more than 8 lbs., including print head, removable paper cartridge and decoding electronics.

New Look at JPL Is Foreseen

At least one member of the House Science and Astronautics committee has suggested that the next session of Congress should take up the question of the relationship between NASA and JPL. Rep. John Wydler (R-N.Y.) believes it might be better for JPL to operate under the restraints of civil service, as other NASA centers do. He feels that JPL's unique position may have contributed to problems in the *Surveyor* program (see p. 16).

INTERNATIONAL

Italy May Buy Sparrow Missile Here

Official sources say Italy may purchase 1,000 *Sparrow* air-to-air missiles in the U.S. to equip its increasing force of Lockheed F-104's. Raytheon is the manufacturer. Budget plans call for $185 million to be spent in the U.S. for the *Sparrow*, 16 TF-104 aircraft, Vulcan guns and other spares.

GEOS-A Set for Nov. 2

The *Geodetic Explorer* satellite (*GEOS-A*) is scheduled for launch from Cape Kennedy on Nov. 2 aboard a *Thrust-Augmented Improved Delta* booster.

Launch of the 385-lb. satellite will be the first for the *Improved Delta* second stage, which uses enlarged fuel tanks to provide a longer engine burntime.

The spacecraft, containing five geodetic instrumentation systems, will be designated *Explorer XXIX* upon achieving orbit. Desired parameters are an apogee of 920 statute miles, perigee of 690 statute miles, orbital period of 112 minutes, and inclination of 59 degrees.

The five measurement systems aboard the spacecraft include:

—A flashing light beacon to be photographed against the background of stars to define the arc of orbit and angular data;

—Corner cube quartz reflectors to pinpoint the satellite's position by reflecting laser beams;

—Three radio transmitters for Doppler-shift determination of the precise orbit;

—Radio range transponder to fix the satellite's position and that of interrogating ground stations, and;

—Range and range-rate transponder to determine the changing range and radial velocity of the satellite.

LMSC Claims Breakthrough

Lockheed Missiles & Space Co. claims to have solved the major obstacles to long-term space storage of cryogenic propellants—promising a big potential payload increase for future *Apollo* missions.

Working at the $3-million Santa Cruz Mountains Cryogenics Laboratory, Lockheed engineers say they have developed insulation systems and an aluminum alloy fuel tank concept that would make possible storage of liquid hydrogen in space for the duration of an *Apollo* mission and perhaps much longer.

A prototype system has been subjected to environmental stresses of an *Apollo* mission and performed better than expected, according to John Baxter, director of LMSC's research center.

Baxter said the work—company and NASA funded—obviously points to replacing the present non-cryogenic *Apollo* propulsion module with one using liquid hydrogen and LOX.

If the switch were made, he said, the *Apollo* lunar payload could be increased from 26,000 to 41,000 lbs. without increasing the weight of the propulsion module. Baxter said the technology is available now to begin work on such a stage, although he said it is doubtful such a program would get funded because of NASA's already saturation commitment to *Apollo*.

Company researchers have been making headway on the problems of insulation, structures and materials for cryogenic propulsion modules. The firm postulated a design for a cryogenic *Apollo* propulsion module utilizing a spherical hydrogen tank 14 ft. in diameter containing about 5,500 lbs. of hydrogen, and has built a half-scale prototype.

Martin Names START Subs

The Martin Co. has selected seven major subcontractors for work on its *SV-5D* maneuverable lifting body reentry spacecraft.

Honeywell, Inc.'s Aeronautical Div. will provide a combined entry guidance attitude reference; Goodyear Aircraft Co., recovery system; Leach Control Div. of Leach Corp., tape recorder for onboard storage of instrumentation data; Borg-Warner's Pesco Div., motor pump for the hydraulic system; Sterer Manufacturing Corp., nitrogen gas-powered thrusters; United Electrodynamics Div. of Teledyne Industries, a PDM commutator; and Motorola, Inc.'s Military Electronic Div., a decoder.

Martin is building four spacecraft under the Air Force Spacecraft Technology and Advanced Re-entry Tests (START) program. They will be used to study hypersonic, controlled flight characteristics from orbital altitudes down through the Earth's atmosphere.

NSF Reports on Federal R&D

While Federal obligations for development have fallen off very slightly from FY 1965 levels, obligations in basic and applied research have increased by 13% and 10% respectively in FY 1966.

According to a survey made by the National Science Foundation, obligations for basic research are expected to increase to $2 billion, and applied research to a total of $3.6 billion. Development is expected to decrease by 1% from $9.8 billion in FY 1965 to $9.7 billion in FY 1966. However, obligations for the R&D plant are expected to drop 50%, because of completion of a number of test facilities and launch complexes in support of NASA's *Apollo* program. Total construction obligation was estimated at $0.9 billion.

Rocket Torpedo Delivered

Aerojet-General Corp. has begun delivery of the Mark 46-0 anti-submarine torpedo to the Navy after six years in development.

The Navy plans to spend more than $100 million for mass production of the anti-submarine weapon. The underwater guided missile can range deeper and farther than previous anti-submarine weapons and can be launched by destroyers, frigates, long-range aircraft squadrons and specially designed drone helicopters, the firm says. It is the first torpedo to be powered by a solid-fuel rocket motor.

IBM, NASA Discuss $80-M Pact

The space agency is negotiating with IBM Federal Systems Div. for continued support of the real-time computer complex at the Manned Spacecraft Center.

The contract extension will cost approximately $80 million and will contain provisions for converting to incentive arrangements under discussion. The work calls for conversion to new IBM 360 computers and use of advanced multi-program techniques to increase capabilities for *Apollo* missions.

AUTODIN Expansion Begun

The first step in a planned expansion of the Automatic Digital Network in the U.S. will be the opening of a new defense communications system automatic electronic switching center early next month.

The center, located at Hancock Field, Syracuse, N.Y., will be operated by the Naval Communications System for the Defense Communication Agency. It will be the sixth such center in operation, with three additional centers planned for Albany, Ga., Fort Detrick, Md., and Fort Leavenworth, Kan.

Expansion of AUTODIN in the U.S. is to provide increased communications facilities for the military departments as well as the Dept. of Defense. The Defense Supply Agency has recently been added to the system.

LAST CHANCE TO FILL UP FOR 48,539,700 MILES

o explore Mars, and planets beyond, an will need refueling platforms rbiting the earth. These orbital filling stations will store cryogenic fuels that spaceships can rendezvous d take on a tank-full of high engy propellant.

ormally, large, elaborate facilities e needed to store super-cold fuels ich as liquid hydrogen. But now ckheed has developed and tested simple, unique insulation system hich will help man exploit the eat efficiency of cryogenic fuels r space exploration.

The usual insulation approach has involved dozens of delicate layers of foil and tissue paper contained in a vacuum. These fragile layers have posed extreme handling problems. Using similar materials, Lockheed has solved handling and insulation problems with a technique based on buttoning the layers together. Lockheed's buttoned layers keep minute amounts of heat from leaking into fuel tanks — and they can be handled under factory conditions.

The Lockheed system has passed space chamber tests. It has survived the rigorous environment of countdown and launch at Lockheed's cryogenic flight simulator facility at Santa Cruz, California. These tests have proven that cryogenic fuels can be stored in space — to make possible payloads double and triple those of today.

Insulation systems such as this are just one measure of the technological competence of Lockheed: a corporation dedicated to the conquest of new worlds through innovation.

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Senior Systems Analysts with 10 years' electronic systems experience —at least 5 years relevant to high-resolution systems pre-design and evaluation. Applicants will be considered for assignments in concept formulation; single and multi-sensor applications; data transmission, processing and interpretation; systems integration and performance evaluation. M. S. or Ph. D. required.

Systems Analysts with 5 years' experience in: detection of signals in noise, optimum filter theory, nonlinear signal processing, information theory, MTI and doppler systems analysis. B. S. or M. S. required.

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Rickover Raps Defense Profits

Admiral Hyman G. Rickover has again charged that the defense industry is making more profits on contracts than it states, with true profits "more like 15% rather than the 3% levels that the Department of Defense states."

In testimony just released by the House Defense Appropriations Committee, Rickover recommended overhauling the negotiated fixed-price contract used by DOD when it applies to complex equipment. He indicated that part of the difficulty lies in the fact that the Government has no requirements on real standards for industry accounting systems for so-called "fixed-price" work. "In some cases it is almost impossible to distinguish between profit and cost for negotiated fixed-price contracts," he said.

UAC To Market Boron Filament

Universities, research groups and other interested organizations can now purchase boron filaments from the United Aircraft Research Labs East Hartford, Conn., at $1,500 per lb.

There is some 70,000 ft. of 0.004-in.-thick boron filament to the pound. Wesley A. Kurt, director of research, says that the UAC deposition process produces filament with an average length of 2,000 ft. having uniform characteristics and physical properties.

UAC manufactures the filament in a pilot plant by a continuous, high-temperature process in which boron is chemically deposited on a base of fine tungsten wire. Such filaments have a potential as reinforcing agents in both plastic and metal matrices for high-temperature and highly loaded structural parts.

Yarmolinsky Made DOD Aide

Adam Yarmolinsky, former special assistant to Secretary of Defense McNamara, has been named deputy assistant secretary of defense for international security affairs.

Comsat Gets New Concepts

Communications Satellite Corp. has received three proposals for an advanced satellite for use in its global communications satellite system.

Although no foreign firms submitted bids, indications are that for the first time foreign companies will share substantially in subcontracting activities.

In its RFP, the corporation requested that the advanced satellite be for use either in a synchronous orbit or a phased system at medium altitudes. Specifications call for a capacity of 1,000 two-way voice circuits, a minimum five-year lifetime and a capability for single or multiple launch.

Comsat also announced plans to award a $4.5-million contract to Page Communications Engineers, Inc., for three transportable ground stations for use in Project *Apollo* communications (M/R, Aug. 23, p. 9).

Comsat filed the contract last week with the Federal Communications Commission along with applications for authority to construct the stations and request for FCC approval of their technical characteristics. Still pending before the FCC is a Comsat filing to purchase satellites for the space portion of the system (M/R, Oct. 25, p. 12).

Shots of the Week

X-15 pilot John McKay on Oct. 27 flew the rocket plane to an altitude of almost 45 mi. at a speed of Mach 4.7 in a mission to record noise intensity on the boundary layer of air flowing next to the surface of the plane.

- The *Atlas-Agena* portion of the planned *Gemini-Titan-Agena 6* failed Oct. 25, thus cancelling the manned portion of the mission (p.12).

OGO-II Second Disappointment

OGO-II failed Oct. 24, apparently as a result of its horizon sensors locking on to a spurious Earth horizon rather than the real thing.

The satellite was placed into an acceptable orbit after launch on Oct. 14 and had avoided the boom-deployment problem that curtailed performance of its predecessor, *OGO-I*. However, the horizon sensor malfunction caused the craft's controllers at Goddard to expend the attitude control system's cold gas propellant without regaining control of the satellite.

The third in the seven-flight series is still planned for launch during the first quarter of next year in accordance with the original schedule, but this could be changed by the investigation of *OGO-II* under way.

Two Die in Thiokol Fire

Two employees were killed and three others injured Oct. 27 in a fire at an Air Force plant operated by Thiokol Chemical Corp.'s Wasatch Div. near Brigham City, Utah.

Air Traffic Control

People needed in MITRE's Washington, D. C. office to provide system engineering assistance to the Federal Aviation Agency. Work areas include broad level system design, computer program operational specification, configuration management, system integration and system test planning.

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Telemetry

Engineers are needed to work with telemetry and instrumentation. Particular work areas include telemetry standards, systems, and techniques for both airborne and ground applications. Experience should include design or analysis of telemetry systems as well as modulation theory, RF techniques and receiving and transmitting antenna systems.

Range Data Transmission

Engineers are needed to work on range data transmission. Particular work areas include digital data transmission systems analysis and testing. Experience with switching systems, modulation and information theory, and coding is desired.

Systems engineers needed for work in these vital areas!

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Entire Gemini Flight Schedule Slips

GT-7 launch is still due in early December, but next attempt at docking is off until 1966; panel studies Agena destruction

DESTRUCTION of the ill-fated *Agena* target vehicle has killed NASA's plans to complete the two-man *Gemini* program by October, 1966. It has also put off a rendezvous and docking mission until the first quarter of next year at the earliest.

Space agency plans for the program were disrupted when the *Agena* was destroyed—probably by an explosion—on Oct. 25 shortly after a perfect launch from Cape Kennedy by its *Atlas* booster.

Its destruction brought a quick halt to NASA plans to launch the *Gemini 6* spacecraft with its *Titan II* booster in an attempt to rendezvous and dock with the target vehicle.

Space agency officials immediately decided to postpone the *GTA-6* flight until the cause of the *Agena* loss was pinpointed. Instead, they announced that they would move ahead with the 14-day *Gemini 7* flight, expected to be launched about the second week in December.

While there had been speculation that the launch of *Gemini 7* might be moved up into November, NASA promptly killed that hope by announcing that it would not use the *Gemini 6 Titan II* launch vehicle for *Gemini 7*. Instead, it ordered the launch vehicle designed to boost the *Gemini 7* to Cape Kennedy, where it was erected and integration of its spacecraft payload begun on Oct. 29.

● **Report pending**—Officials said they would not speculate as to just when the *Gemini-Titan-Agena 6* mission might be rescheduled until groups at the Air Force Space Systems Command, NASA's Manned Spacecraft Center, and Lockheed Aircraft Corp., prime contractor for the upper stage, had completed their study of data transmitted from the vehicle before ground stations reported they lost track of it.

They estimated that it would be five to 10 days before the results of the investigation could be announced. Even if no major redesign of the *Agena* target vehicle is required, normal checkout and integration work will delay another rendezvous and docking mission into the first quarter of next year.

Originally, NASA official planning schedules called for *GTA-6* to be launched in October, *Gemini 7* in December, *GTA-8* in February, 1966, *GTA-9* in April, *GTA-10* in June, *GTA-11* in August, and *GTA-12* in October. Failure of the *Gemini 6 Agena* target vehicle to reach orbit has forced at least a two-month delay in that schedule. Major redesign could move the program well into 1967.

● **Too many pieces**—Belief that the upper stage exploded was based on the fact that the NORAD tracking station reported five separate objects in the air shortly after all telemetry was lost. If the *Agena* had achieved its orbit, only three pieces would have been tracked, the *Agena* and two pieces of its shroud. The sudden loss of telemetry just as the primary propulsion system was supposed to ignite also indicated a catastrophic failure.

One probable cause of the apparent explosion, according to NASA officials, was valve failure. This could have led to the sharp increase in tank pressure reported by MSC officials just as the primary propulsion system was to ignite. They said there was no indication of a total electrical power failure.

● **Good beginning**—Weather and sea conditions on the day of launch, Oct. 25, were nearly perfect; the first U.S. simultaneous countdown of two complex space systems, the *Atlas-Agena* and the *Gemini-Titan*, was on time and without holds.

The *Atlas-Agena* was launched at 10:00:04 a.m. EST from Pad 14 at Kennedy Space Flight Center as the second flight system carrying Astronauts Walter M. Schirra and Thomas P. Stafford continued in its countdown on Pad 19. Four minutes, 40 seconds later the *Atlas* secondary engine cut-off occurred, followed by separation about 30 seconds later.

All looked well for the *Agena* until the Bermuda tracking station reported an "abrupt" telemetry cut-off at T plus 6 min. 10 sec. Then came a report indicating that the *Agena's* secondary propulsion system had ignited and at the 18-sec. point, when the primary propulsion system was to have been started, a sudden build-up in chamber pressure was recorded. It was at about this time that not only telemetry but all beacon signals were lost.

THIS REPORT on the failure of the GTA-6 mission and its effect on future planning for the Gemini program was prepared by Senior Editor Charles D. LaFond, NASA Editor Hal Taylor, and Contributing Editors Jinx Mercer and Sue Butler.

● **Doubt grows**—There were reports for a short time that Bermuda was still receiving sporadic S-band beacon signals and that C-band signals were being received downrange. Neither report has since been confirmed by NASA's Mission Control Center at Houston.

(Air Force Range Safety later reported that all beacon signals were lost downrange at T plus 6 min. 16 sec. and that skin-tracking radars began search at T plus 9 min. 20 sec. One station, reportedly at Patrick Air Force Base, indicated momentary track of five objects some 1,500 mi. downrange, northeast of Antigua.)

The *GT-6* countdown was continued, but by T minus 70 min. completion of the mission was in great doubt. The *Gemini 6* launch window was tied to a maximum of two *Agena* revolutions about the Earth.

NASA's tracking stations around the globe searched continuously in an attempt to locate the wayward vehicle. At T minus 42 minutes the *GT-6* countdown went into a hold and observers awaited some word from the Carnarvon, Australia, tracking station. Finally, at about 10:50 EST, Carnarvon reported no contact and at 10:54 the mission was scrubbed.

During the post-mortem for the press shortly after termination of the mission, NASA officials stated that at least 5 to 6 days would be required for Lockheed Missiles & Space Co., *Agena* prime contractor, and NASA scientists to anaylze tapes of the ground-recorded data and make some meaningful determination of the *Agena's* malfunction.

● **Agena record excellent**—The past record of the *Agena* series of space vehicles speaks for itself, and no excuse is required to bolster it now. Since launch of the first *Agena* on Feb. 28, 1959, over 185 of the Lockheed-built vehicles have been launched into space, achieving an unusual reliability of 88%. Over 90 of these have been the more sophisticated *Agena-D's*, which have attained a reliability of better than 93%, according to Air Force estimates.

Conclusion-jumpers, following last

week's space failure, immediately pointed their fingers toward the *Agena* rocket engines as source of the failure. This may be, said one official of Bell Aerosystem Co., developer of all the *Agena* propulsion systems; but he pointed out that the primary thrust systems have an almost perfect operating record.

To date, *Agena* PPS have had 204 starts and restarts in space with only one failure (restart in the *Ranger II* mission). Thus, the PPS has an observed reliability of 99.5%, the official said.

- **No ATV flight test**—During last Monday's after-mission press conference, Dr. George E. Mueller, NASA's Associate Administrator for Manned Space Flight, in answer to a question, stated that the Target Vehicle version of the *Agena* as developed for the rendezvous and docking task was in essence a standard *Agena-D* with "add-ons." He also stated that no pre-mission flight testing of the *Atlas-Agena* was scheduled because of money limitations.

In other words, he said, NASA took a calculated risk in by-passing flight-testing because of inherent reliability of the vehicles in the past.

However, Maj. Gen. Ben I. Funk, director of the AF Space Systems Div., when questioned at the same conference, implied that modifications to the ATV were rather extensive. What he diplomatically did not say was that the Air Force for over a year, and as recently as six months ago, persistently sought to obtain NASA approval (and funds) to perform at least one full-dress rehearsal of the *Atlas-Agena* performance for the *GTA-6* mission.

To further indicate the extent of modifications in the *Agena* as flown, one industry informant disclosed to M/R that the first such vehicle—No. 5001, located at Cape Kennedy—has undergone continual retrofit to match the second and third vehicles—No. 5002, which was used in the *GTA-6* mission and No. 5003, now undergoing final checkout at Lockheed's Sunnyvale, Calif., facility.

(*Agena* TV No. 5001 has been used at the Cape for ground test and training. It is reported to be flight-qualified now, as is another *Atlas* booster also located at the Cape. Dr. Mueller, in the press conference, pointed out that a back-up *Atlas-Agena* would have intolerably complicated an already complex trial countdown. He did not mention, however, the availability of a second system or the fact it might conceivably have been made ready for an early repeat of the mission.)

- **Subsystem tests**—An Air Force spokesman told M/R that some of the ATV subsystems have been flight-tested on other *Agena-D* missions. He did not elaborate on what subsystems had been flown.

A Bell Aerosystems official did disclose that the turbo pumps and new PPS thrust chamber were tested separately and extensively prior to mating with the complete engine.

Acceptance testing of the first fully integrated ATV (No. 5001) was made during the period of August-October, 1964. During October, 1964, the engine was put through a 1-min. firing, then shut down; three firings of 2-sec. duration; a 1-min. firing with two periods of gimballing.

There seems to be some disagreement as to whether the Air Force ever legally accepted this first vehicle from Lockheed. While engine tests were reportedly satisfactory, there apparently were problems in the command-system electronics. Nevertheless, this vehicle ultimately was in fact accepted for use at the Cape.

The second vehicle, No. 5002, reportedly was accepted (after incorporation of considerable design change of subsystems) in August, 1965, and shipped to the Cape for subsequent mating with the *Atlas* booster.

- **Agena TV modifications**—One Air Force spokesman told M/R that he estimated the *Agena-D* has been modified internally and with add-on's by as much as 75% for its role as *Gemini* target vehicle.

J. D. Sailor, Lockheed's NASA Programs System Integration manager in Sunnyvale, detailed the *Agena* modifications before the AIAA Manned Space Flight meeting in St. Louis earlier this month (M/R, Oct. 18, p. 35).

In summary, changes to the basic *Agena-D* include:

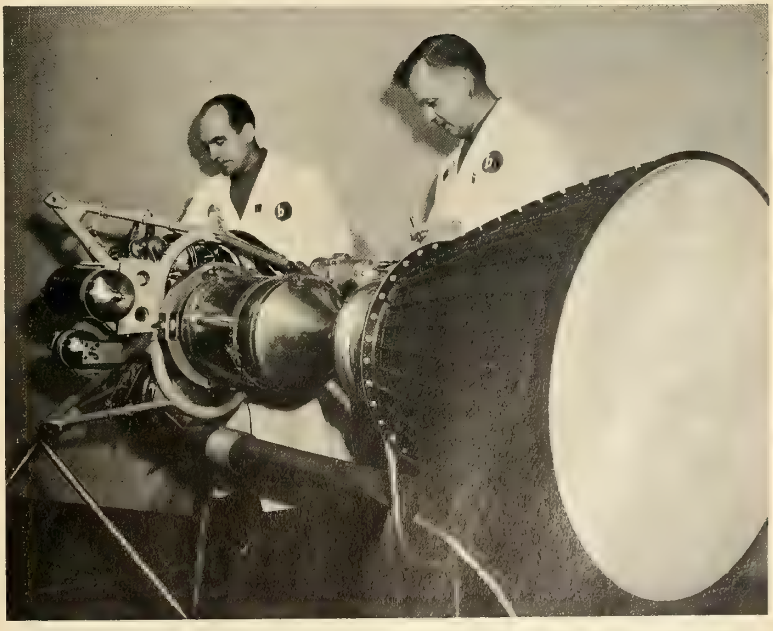
—*Structural*—Addition of a forward 17-in.-long x 60-in.-dia. mounting rack for added batteries and the new command and communications electronics; the target docking adapter, aft, which also carries the rendezvous L-band transponder and an erectable antenna, docking collar and docking dampers, status display panel and flashing acquisition lights.

—*Propulsion*—The normal two-start Bell Aerosystems liquid engine was redesigned to permit five starts largely by replacing the conventional *Agena* solid-propellant start charges with small liquid-propellant start tanks, including bellows, valves and an electronic speed gate; a secondary storable-liquid propulsion system located on either side of the aft rack, including pressurization bellows and ullage control.

—*Attitude control*—Minor changes indicated addition of a means for loading the velocity meter in orbit plus extra reaction-thrust-gas bottles.

—*Guidance*—Addition only of a flight-control logic package and a filtering network.

—*Command and control*—Addition of a ground-compatible PCM telemetry system, including two transmitters and a tape recorder; a UHF PCM command receiver; and a command programmer (M/R, Oct. 25, p. 24). ■



NEW AGENA rocket engine developed by Bell Aerosystems for GTA-6 target vehicle was given cylindrical fuel and oxidizer start tanks (at left above).

Army Weighs New Air-Defense System

Decision pending on new Redeye-type weapon; industry proposals of new missile developments mark AUSA meeting

by Michael Getler

THE ARMY IS NOW considering initiation of studies of a new air-defense missile system believed to involve an advanced shoulder-fired weapon with greater range and kill probability than the current *Redeye*, which is now going into production.

Army Missile Command is believed to have come up with the concept and to have suggested further study. Officers say there is no present indication as to when a decision may be made on letting any out-of-house contracts.

In addition to the Army's own suggestions, proposals for new tactical missiles—particularly shoulder-fired, anti-hard point weapons and helicopter-mounted armament—continue to pour out of industry R&D laboratories as contractors strive to meet demands created by the Vietnamese war.

Last week, several new systems—emphasizing unguided, rocket-powered conventional ammunition linked to relatively simple firing mechanisms—were publicly displayed for the first time at the Association of the U.S. Army meeting in Washington, D.C.

They included an anti-tank missile entry by Lockheed Missiles & Space Co., a family of solid rocket-powered ammunition and weapons ranging in caliber from 15 to 105 mm developed by Avco Corp., and a 105-mm recoilless rifle designed by Lockheed Propulsion Co. to fire a rocket-assisted projectile from helicopters or field positions.

Apart from the new proposals, North American Aviation, Inc.'s Columbus Div., manufacturer of the *Redhead/Roadrunner* target missile, has put forth that system as a candidate for a long-range tactical weapon system.

- **Anti-tank Viper**—Lockheed's company-funded anti-tank system, known as "Viper," is a tube-launched missile propelled throughout its flight by a solid-fuel, spin-rocket motor which also provides stabilization. The missile, which requires neither guidance nor tracking, reflects the firm's intention to stay away from wire-guided missiles, which Lockheed spokesmen feel "are not tactically acceptable for all applications." The operator of the 25-lb., shoulder-fired Viper uses only an optical sight on the launcher for aiming at targets within line-of-sight.

The missile, traveling at Mach 3, will fly a flat, non-ballistic trajectory, according to the firm. Viper is designed, they report, so that the minus-1-g regressive thrust vector of the main motor compensates for the missile weight decrease during powered flight, thereby maintaining the no-ballistic-drop characteristic. Supersonic flight also removes wind-induced errors.

Lockheed spokesmen told MISSILES AND ROCKETS that tests of key components will be completed late this year, and that the firm expects to begin flight tests in mid-1966. Solid motor development is under contract; Lockheed will not identify the contractor, but it is not Lockheed Propulsion Co.

Lockheed engineers say the system can be scaled up or down for use in the field or aboard vehicles, but the firm is said to be most interested in the current Army competition for a new medium anti-tank assault weapon (*MAW*), hoping to exploit what it believes to be accuracy and cost advantages.

Current entries in the *MAW* competition include a wire-guided system developed by McDonnell Aircraft Corp., which has just undergone a perfect string of 13 successful firings, and a free-rotor gyro missile developed by Army Missile Command.

- **Gun family**—AVROC, developed by Avco Corp.'s Ordnance Div., is a family of new gun systems, ranging from a 2-lb., 15-mm pistol designed as a survival weapon for downed pilots to a 105-mm aerial artillery piece. All use ordnance propelled by solid-fuel rocket motors of varying length.

The 105-mm gun has been proposed to the Army for use aboard HU-1B helicopters.

The weapons are closed chamber systems in which the rocket gases emitted during the previous firing are used to automatically cycle the next round into the chamber. Since the propulsion system travels with the warhead, there are no cartridge cases.

Projectiles leave at low muzzle velocities, according to the firm, accelerating rapidly after leaving the barrel. This allows correspondingly low gun pressures, minimizes recoil and provides a lighter system, engineers state. Avco also claims the projectiles have a spin rate sufficient to retain stability during lower-speed flight. Spokesmen say the technique is three times more accurate, over a greater range, than conventional weapons of similar caliber.

Avco has had some funding for accuracy-testing of a 15-lb., shoulder-fired 40-mm weapon, and reportedly will start building a new and larger 40-mm for testing in December. The solid rocket motors are designed to be compatible with existing 40-mm grenade warheads.

- **Recoilless rifle**—The Lockheed Propulsion Co. 105-mm recoilless rifle is also designed for either shoulder firing or helicopter mounting. The weapon weighs 22 lbs., including a round of rocket-assisted anti-tank ammunition.

Representing a new field of interest for LPC, the weapon also introduces a new design concept. Integral with the rifle design is an expendable breech/nozzle section, weighing about 6 lbs. The breech, according to LPC, houses an improved, high-burn-rate solid propellant encased in a foil to insure a properly shaped charge. The charge is used to initiate launch of the round, after which the breech and nozzle, through which exhaust escapes, are ejected aft. LPC states that the expendable breech allows a clip-fed operation that can handle 60 rounds per minute.

The anti-tank round is powered throughout its flight to the target, traveling a flat trajectory at about 1,200 fps. A small rocket motor carries the round to some 75 ft. from the launcher, where the main motor is ignited.

- **Conversion**—*Redhead/Roadrunner*, a subsonic and supersonic cruise-type target missile for both *Nike-Hercules* and *Hawk*, is also reported to be attracting both Army and Air Force tactical interest.

In its present configuration, the system is said to be able to deliver a 250-500-lb. warhead on targets up to 100 kilometers from the launch point. Configuration changes might up this to a 1,000-lb. payload.

As a tactical surface-to-surface missile, the *Readhead/Roadrunner* combination would probably use its current command guidance within LOS range, then switch to a second, independent target seeker, possibly TV.

The ability of the missile to cruise at different speeds, to sustain powered flight, to carry a payload, and to be recovered (by parachute when used as a drone) has also led to informal proposals to Army Missile Command for use of the vehicle as a flying test bed for new missile guidance systems. ■

Apollo Acceleration Hinted by NASA

Program schedule prepared by MSC indicates first three-man launch may go next October—three to six months early

by Hal Taylor

THIS NATION'S FIRST three-man spaceflight in the *Apollo* spacecraft may be launched as early as October, 1966—three to six months earlier than NASA has officially announced.

Officially, the space agency has revealed only that the flight would be made in the first quarter of 1967. Informed sources, however, report that NASA's planning schedule lists the shot for early in the last quarter of next year. It had previously been slated for September of next year, but a one-month slippage was forced when the first *Apollo* flight test spacecraft was delivered to NASA late, forcing a delay in its launch from this December to January, 1966.

The schedule prepared by the Manned Spacecraft Center also calls for two unmanned launches of the *Apollo* spacecraft next year, with perhaps a second manned spaceflight in December, 1966.

SA-203 in July will be an unmanned orbital flight with the primary purpose of monitoring the way liquid hydrogen in the S-IVB second stage reacts to the space environment.

SA-204, the first manned flight, would then be attempted with a planned duration of eight to 14 days. *SA-205*, another manned orbital flight, would follow before the end of 1966.

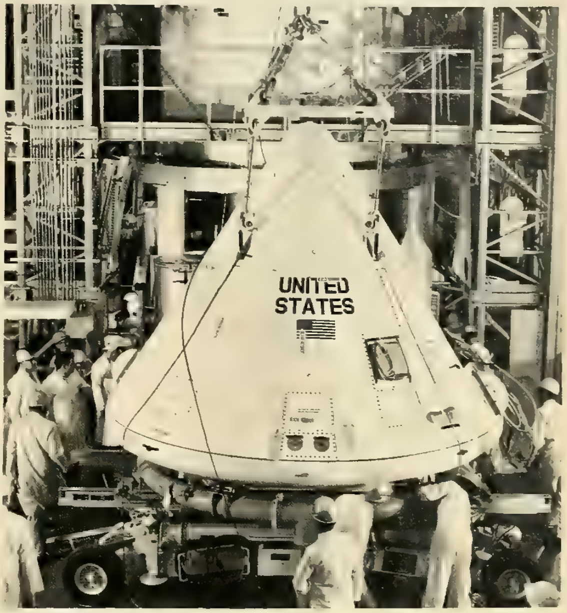
The rest of the *Apollo* schedule calls for five flights in 1967, eight in 1968, six in 1969 and two in 1970.

- **Two schools of thought**—The schedule assumes a completely successful program. While this may be impossible to achieve, the space agency's chances will be enhanced from 1967 on because it will have two launch pads available for the *Saturn V* booster at Cape Kennedy.

The Vehicle Assembly Building—in which the *Saturn V* and the *Apollo* will be mated—also will have the capability of integrating four vehicles at one time.

Optimistic NASA officials believe that the first U.S. manned lunar landing flight can be attempted on the fifth *Saturn V* flight if the two unmanned and two manned flights preceding it are successful. The fifth flight is now set for April, 1968.

Pessimistic officials believe the lunar landing will not be attempted until the ninth or tenth flight, now set for March and May, 1969, respectively.


APOLLO spacecraft 009 under scrutiny by computerized acceptance and checkout equipment (ACE) at North American Aviation's Space and Information Systems Div. before being accepted by NASA. GE makes the ACE equipment. Spacecraft is the first Apollo flight model, scheduled to be launched next January.

According to the *Apollo* schedule, there are 12 missions planned with the *Saturn IB* vehicle. The last one in this series is scheduled for December, 1968. *Saturn V* missions—a total of 15—are shown terminating with *Saturn-Apollo 515* in January, 1970. The first flight is set for December, 1966.

The first "all up" flight of the complete *Apollo* spacecraft, including the Lunar Excursion Module (LEM) is shown scheduled for April, 1967, on the *Saturn-Apollo 502* unmanned mission. This will be preceded by *Saturn-Apollo 206*, which will loft the LEM into orbit from a *Saturn IB* launch vehicle. This flight, also unmanned, is listed for March, 1967.

- **Schedule and experiments**—The post-1966 schedule follows (200 series are *Saturn IB* launches and 500 series designates *Saturn V* missions):

1967: *SA-206*, March; *SA-502*, April; *SA-207*, June; *SA-503*, September; *SA-208*, October.

1968: *SA-504*, January; *SA-209*, February; *SA-505*, April; *SA-210*, May; *SA-506*, July; *SA-211*, August; *SA-507*, October; *SA-212*, November.

1969: *SA-508*, January; *SA-509*, March; *SA-510*, May; *SA-511*, July; *SA-512*, September; *SA-513*, November.

1970: *SA-514*, January; *SA-515*, January.

The Command Module for the 009 spacecraft arrived at Cape Kennedy Oct. 25. The Service Module was scheduled to arrive there late last week or early this week. During the mission, the spacecraft will thrust its way back into the atmosphere from about 280 mi. up, using the service module's propulsion engine to reach a speed of 18,750 mph. The speed is about 10% higher than the re-entry velocity encountered after Earth orbital flights. The flight will probe the design of the spacecraft heat shield for early *Apollo* flights.

The first manned mission (*SA-204*) will carry the following experiments: cardiovascular conditioning, bone demineralization, human otolith function, cytogenetic blood studies, and exercise ergometer.

For *Saturn-Apollo 205:* body fluids balance study, bone demineralization, calcium balance study, human otolith function, cytogenetic blood studies, exercise ergometer, metabolic rate measurement, pulmonary function, frog otolith function, zero-g single human cell, trapped particle asymmetry, X-ray astronomy, micrometeorite collection. ■

Report Raps Surveyor Management

Space agency headquarters, JPL, Hughes taken to task for delays, mushrooming costs, by panel from NASA oversight subcommittee

by Heather M. David

LAX MANAGEMENT by NASA Headquarters, neglect by the Jet Propulsion Laboratory and some evidence of a disappointing performance by Hughes Aircraft Co. have been blamed for delays and cost overruns in the *Surveyor* lunar vehicle project.

The findings are related in a report on Project *Surveyor* based upon information developed during a two-day onsite inspection of the *Surveyor* project at JPL and Hughes by a special panel on *Surveyor* of the House Space Committee's NASA Legislative Oversight Subcommittee, headed by Rep. Joseph Karth (D.-Minn.).

Among other conclusions, the report suggests that perhaps the project should have been reassigned to another center, in spite of the fact that JPL is recognized as NASA's technical team for unmanned lunar and planetary exploration programs. Other NASA centers have demonstrated capabilities in this field, the panel pointed out, and in fact the *Lunar Orbiter* project is assigned to Langley Research Center.

The group also concluded that communications between NASA headquarters and Hughes Aircraft, the contractor, "seem to have been virtually nonexistent during the first four years of the project up until quite recently."

• **Too little too long**—While applauding NASA for excellent managerial and technical competence in many other space programs—both manned and unmanned—the panel said that NASA's management performance on *Surveyor* "must be judged in the light of a history of too little direction and supervision until just recently."

It said that it was highly desirable that NASA management continue its present high level of attention, and perhaps even increase this, depending upon program progress.

It characterized *Surveyor* as "one of the least orderly and most poorly executed of NASA projects." While a NASA press release of Jan. 19, 1961, said that the project would cost upwards of $50 million, (for seven launches) it has now reached the figure of $350 million through the current fiscal year, with an estimated cost of $725 million to completion of the first 10 flights.

The panel said that in view of the challenging nature of the mission it is not surprising that launch schedules have had to be revised and that costs have increased and payload capability has decreased. However, these changes have been "more far-reaching than the most pessimistic of earlier estimates."

The first launch has been delayed about two and one-half years, and payload capability has diminished to the point that the first four spacecraft are devoid of scientific instruments except for a single scanning television camera. The 1961 press release gave the launch period as from 1963 to 1966 for the seven spacecraft then contemplated, and weight was approximately 2,500 lbs., with 200 lbs. of scientific instrumentation.

Surveyor got off on the wrong foot at the very beginning, the report indicated, and insufficient preliminary work was done before embarking upon the hardware phase. This has led to a series of major modifications and program redirections from time to time during the entire history of the project as technical difficulties were encountered.

• **Jet Propulsion Laboratory**—JPL's involvement with the *Ranger* and *Mariner* projects in-house, plus a manpower ceiling imposed on the laboratory by NASA headquarters, led to a situation in which JPL virtually turned over the *Surveyor* project to Hughes for the first three years, the report indicated.

During the first few years, the number of personnel at JPL working on the project ranged from 20 at the inception, to something less than 100 up until June, 1964.

As *Ranger* and *Mariner* work tapered off, the report indicated, JPL realized that severe technical problems existed with *Surveyor* at the Hughes plant, and a complete design review was undertaken. A rapid buildup of personnel on *Surveyor* was undertaken at JPL, the team grew to approximately 500 and other organizational changes were made.

Concerning JPL's management, the panel said that "the committee believes that JPL's technical penetration into the program at Hughes should have been more substantial during the first three years of the existence of the project, and does not regard JPL's preoccupation with its in-house work as justification for its failure to exercise the degree of technical direction required. . . ."

• **Hughes**—While Dr. William Pickering, JPL director, has denied any displeasure with the manner in which Hughes has operated on *Surveyor*, the subcommittee panel said it believed that he was being "overgenerous."

The panel indicated that NASA's displeasure with Hughes management is implicit in the fact that JPL brought great pressure upon Hughes to reorganize its management along project lines after the 1964 design review.

Hughes has complied only partially with this recommendation, the panel said, and in fact, the general manager of Hughes, L. A. Hyland, "has denied that there has been any substantial change in his organization."

Other factors contributing to this implication, the report indicated, are the fact that JPL has gone into the technical aspects to a great depth with its own personnel, and has taken over management of the vernier engine.

The report also cited testimony indicating that Hughes agreed that the drop tests weren't prepared for or conducted properly, resulting in two test failures.

• **NASA headquarters**—The panel said it was well aware that *Surveyor* is one of NASA's more difficult projects, and that this has accounted for some of the costs and delays.

However, the group said that it was convinced that management weaknesses —lack of vigorous centralized management and effective control at the top— have contributed significantly.

"Some affirmative action should have been taken by NASA headquarters to stimulate JPL's attention to *Surveyor*, and achieve adequate performance on the part of the Laboratory." If the manpower ceiling was a problem, the panel indicated, this ceiling should have been lifted by NASA headquarters.

The report also suggested that more direct control of the project should have been exercised by headquarters, and more of the three-way—headquarters, JPL and Hughes—meetings instituted in the summer of 1965 should have taken place earlier.

The group characterized the project as a special case which, in view of its complexity, should have enjoyed more direct, continuing and active interest on the part of NASA headquarters. This might have produced better response at Hughes, the panel indicated. ■

National Information Program Impends

President Johnson may urge undertaking in next budget message; Government alone obligating $380 million in FY '66

by William S. Beller

SITTING IN FRONT of a teletype machine in a small Pentagon office, a scientist dials a number that connects him to a computer at the System Development Corp. in Santa Monica, Calif.

He asks the computer how many others are using it, and the answer comes back, "Seventeen."

Thus assured that his work will not overload it, he asks the computer how many bibliographic references it can give him on lasers, and the number is quoted in the hundreds. "Ruby-lasers?" The number is less. "Ruby-laser transmitters?" The number is smaller still.

In this fashion, by direct conversation with the computer, the operator can home in on the precise references he wants, read abstracts of those he is interested in, entire texts if he desires—without leaving his seat or speaking to another human being.

This seemingly ideal way to research a technical or scientific project is in being on an experimental basis at a score of companies and universities around the country and at the Advanced Research Projects Agency (ARPA) in the Pentagon. It is part of a multiple-access-computer research program initiated and supported by ARPA since 1963 and aimed at putting users in closer coupling with their computers.

This program is only one of several schemes a White House Committee is looking into in an effort "to develop a long-range plan for further improvement of national scientific and information systems." Another idea: let computers hand-tailor journals for the needs of individual users.

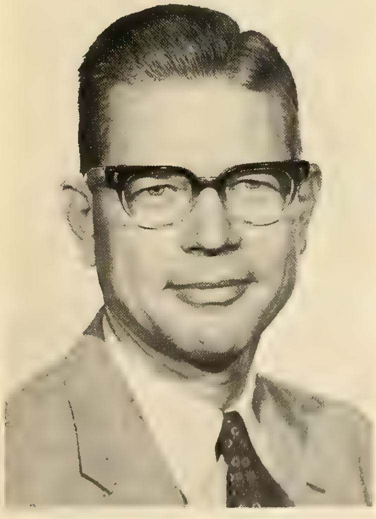
● **National program seen**—There is little doubt the Administration will soon formulate and announce plans for a national information program. This conclusion is based on: 1) suggestions from several committees of Congress that the Executive branch exercise stronger, more aggresive leadership in the information area; 2) resulting top-level planning effort of the Committee on Scientific and Technical Information (COSATI), a task group of the President's Federal Council for Science and Technology; 3) finding of the System Development Corp. that such a national effort is essential for pre-eminence in science and technology. The company report on this subject, not yet released, was written for the COSATI group under a contract with the Department of Defense and paid for by seven government agencies, coordinated by the Federal Council.

William T. Knox, COSATI chairman, told MISSILES AND ROCKETS, "It is possible the President will call for a national information program in his next budget message to Congress." Knox hastened to stress, "This is merely my feeling about it," and he added, "it would depend entirely on the reactions of the various advisory groups to the President, and on the President."

Asked if the mechanism is at hand to start such a program if it were approved, he answered, "Let's say we have an existing system." Knox would not detail its structure but did say that his task group's report would come out this fall.

Vice President Hubert Humphrey has probably cast his vote for a national program if his past interest in scientific and technical information activities, even as a Senator, is any measure.

● **An Executive order**—The temper of the Administration is perhaps best reflected in a memorandum the Bureau of the Budget issued last month to the heads of all Federal agencies. It was called for by the President and introduces an integrated planning, programming and budgeting system to the Executive branch.



COSATI Chairman William T. Knox—LBJ call for program "possible" in January.

The new system rests on three concepts, one, a planning and programming process "which incorporates and uses an information system to present data in meaningful categories essential to the making of major decisions by agency heads and by the President."

Nothing is said about having compatible systems. Nonetheless, for the agencies to work together, they will have to be able to enter one another's information systems, and this fact is expected to lead to the greatest pressure for a uniform national system.

The other two concepts in the new system call for agencies to outline their broad objectives, and the programs needed to meet them, and a budget process that can translate program decisions into a ledger sheet.

● **Expensive program**—Large amounts of money are going into the Government's science and technical information programs, and increasing amounts are expected. Expenditures by Executive agencies for Fiscal Year 1965 are estimated at $201 million. For Fiscal Year 1966, COSATI estimates obligations for these same agencies of $380 million. Of this, $130 million is for publications and distribution work, and $80 million for bibliographic and reference service. The remainder is concerned with supporting R & D information sciences and systems, technical meetings, information centers, translations and support of scholarly publications.

The Defense Department spends the most money for its information programs, followed not too closely by the Commerce Department and Department of Health, Education, and Welfare. NASA is fourth in line.

● **Likened to bacteria**—In the overall picture, individual agency obligations for scientific and technical information vary from less than 1% to 17% of total research and development funds. Although individual agencies have differing reporting responsibilities to the scientific community and the public, the chief of the science and technology division of the Library of Congress believes that 10% of an agency's R & D funds is a realistic amount to spend on dissemination of scientific and technical results.

Publication of scientific works in journals and papers as we know them started around 1690 and has roughly doubled in volume every decade since. An observer recently pointed out that this growth curve is now hyperexponential—doubling in size every seven years. This fact moved Harold Wooster, a Defense Department scientist, to note that the curve bears a striking similarity to the first half of the growth curve for a bacterial colony—before it starts poisoning itself with its own waste products.

He cited several analogous signs ranging from technical libraries outgrowing their shelf space before they're built to duplication of expensive research projects.

● **Scientists the drag**—What a national information system means is that every engineer and scientist could have at hand all releasable information contained in every major library and research facility in the nation. This information would presumably be properly indexed and abstracted to make retrieval easy. With such a tool, called by some enthusiasts, "the greatest invention since the book," technicians would spend fewer hours searching and more in creative activities.

Oddly enough, scientists and engineers themselves are apparently loath to change their way of getting information. They much prefer picking up the telephone and asking a colleague a question, or having a "bull session" at one of the many scientific meetings to reading a report or monitoring a computer. Although human, this procedure is not believed to be efficient.

These findings are coming out of a current study of the Space & Information Systems Div. of North American Aviation, Inc., in which engineers and scientists at 100 representative companies were interviewed to learn their attitudes toward the information problem. A leading DOD worker in the information field compared the findings with the response of a traditional farmer who, when asked how he could till more land, said, "Give me more mules and hay to feed them." He did not propose using a four-wheel mechanism that drinks gas because he did not know its merits.

● **Do they need it?**—In a minority view, the professional altruism of scientists has been questioned. A Yale historian of science suggests that the main reason a scientist publishes a paper is to stake out and record his claim. Only incidentally, complains Derek J. de Solla Price, does the paper serve as a carrier of information, an announcement of new knowledge for the good of the world, or a gift of free advantage to one's competitors. Scientists "have a strong urge to write papers, but only a relatively mild one to read them."

Thus, the amount of scientific information may be smaller than the volume of technical papers indicate, chiefly because of the amount of chaff in with the wheat, and the information problem is a chimera. This is implied in a statement by Dr. Philip H. Abelson, editor of *Science*, who does not see the main purpose of the scholarly journal as one to provide scientific information. It exists "to keep the scientific community honest," he told the House Select Committee on Government Research last year. "That is the most important role of all—where a man has to put down on paper what he has done and where the hostile eyes of the rest of the community can look over it."

● **Using what exists**—The consensus of informed opinion is that any national information system must draw upon the libraries and other facilities already set up by the professional societies, major universities and institutions, Federal government, and private organizations.

These agencies are looking into the information problem. Dr. Burton Adkinson, representing the National Science Foundation, indicated several avenues now being explored: The American Chemical Society has learned how to take a typewritten manuscript, put it into a computer, and come out with a composed page ready for the offset printing camera.

Continuing, Adkinson pointed to the work of the National Library of Medicine that by means of a photocompositor is able to organize the *Index Medicus* in 12 hours, a project that previously took six weeks. He spoke of the ability to put graphic material, such as chemical compounds, into computers, and soon more sophisticated graphics such as halftones.

Adkinson referred to ARPA's Project MAC (Multiple-Access Computer) as the first program to demonstate that computers can be shared by several users operating at the same time from different locations. This eliminates the queueing problem to a large extent and points to the economical use of computers for information work. Robert Taylor, ARPA's deputy director for information processing, credits J. C. R. Licklider, formerly ARPA's director for information processing, with conceiving and sponsoring the initial research effort on the real-time, multiple-access use of computers under Project MAC.

● **Role of private industry**—"The one problem demanding our greatest attention at present is that of creating a permanent mechanism for insuring the effective and efficient management of the vast, far-flung, almost incredibly complicated series of functions which together make up the national information network," Knox told the House Subcommittee on Science, Research, and Development during hearings a few months ago. He noted a few possibilities for a central management mechanism:

—A Comsat-like corporation deeply involved in the actual operation of the information network, with both governmental and private interests.

—A new Federal agency managing all agency scientific-technical functions, much as the General Services Administration handles their services.

—A new Federal agency restricted to top-level planning and evaluation, with existing agencies continuing to manage their internal information system.

—Assignment of top-level planning and evaluation functions to an existing Federal agency.

—A continuation of the present multifaceted management.

● **Scientific data not enough**—In this early stage of trying to organize a national information system, several weaknesses appear. First, nearly all the systems are oriented toward the indexing, retrieval and use of scientific and technical information to the neglect of data that do not fall in these categories. Thus, economic, sociological and legal aspects may figure into the practical solution of a technical problem, especially at high policy levels, but do not figure into the information networks as they are now thought of.

Yet workers responsible for making major decisions are the ones usually most inundated by data, much of it undifferentiated. Perhaps a PERT-type system can be devised that would give all levels of management the information they need without burdening them with details more fitting to lower levels.

If the scope of the national program were extended to include all pertinent information, including sociological and economic as well as technical, the program would take 5-10 years to develop, according to B. J. Hansen, vice president of John I. Thompson & Co.

Second, although informative indexing and retrieving in depth in established scientific fields would doubtlessly help workers in these fields, it would be of less value to scientists whose interests are in more than one field, such as biophysicists, geochemists, and so forth. They would have to parse at least two fields.

Last, the cost-effectiveness of a computer-based information system is not yet proved, although its worth seems intuitively obvious. Nevertheless, it may be necessary to include the problem-solving ability of the computers, in addition to their retrieval capabilities, to make a national information system worth buying. ■

Technical Countdown

ELECTRONICS

Two-in-One CB Laser at RCA

A compact, two-in-one solid-state continuous-beam high-power laser some three times more efficient than conventional units is in operation at RCA's David Sarnoff Research Center, Princeton, N.J. In its present laboratory form, the laser has produced a 10-watt beam of continuous infrared radiation—the second highest power ever reported for this type laser. The device is a garnet crystal composed of yttrium, aluminum and oxygen and containing traces of chromium and neodymium. The first three materials combine to form a molecular framework or host in which the latter two materials are suspended. When a mercury vapor lamp is focussed on the crystal, a small fraction of its light energy is absorbed by the neodymium atoms, which begin to fluoresce. Still more of this light is absorbed by the chromium atoms and some of these also fluoresce. But the majority transfer their newly acquired energy to the neodymium atoms instead, producing a double pumping effect.

Computer Memory Integrated Circuits Perfected

IBM scientists have fabricated experimental integrated circuits for computer memory units on silicon chips some 70 thousandths of an inch square. One chip has 16 circuits with four auxiliary diodes. Each of the circuits has five transistors and four resistors. Thus, 148 components—80 transistors, 64 resistors and four diodes—are contained on one tiny chip. The IBM integrated chips will be used in experimental three-dimensional, scratch-pad memories. In practical applications, the chip approach will increase computer information time by a factor of 10. The small size will afford flexibility in design and packaging and the monolithic chips are compatible with the Solid Logic Technology circuits in the IBM System/360.

New Forms of Epitaxial $GaAs_xP_{(1-x)}$

Epitaxial processes at Texas Instruments, Inc., are producing single-crystal gallium phosphide, gallium arsenide, and gallium arsenide-phosphide in previously unattainable forms and purities. Individual epitaxial layers of each material are available in thicknesses from two microns to 0.025 in. Multiple layers are produced as combinations of GaAs, $GaAs_xP_{(1-x)}$ and GaP, or as separately doped deposits of any desired composition. Precise material composition is maintained across the deposits and throughout thick deposits. Special structures are also available, such as $GaAs_xP_{(1-x)}$ or GaP, of 0.015-0.020 in. thickness overlaid on epitaxial GaAs layers, which form p-n light-emitting junctions. Details can be obtained from New Product Development-MCRD, Texas Instruments, Inc., P.O. Box 5936, Dallas, Tex.

Electronic Bombardier Developed

A programmed bombing pattern that allows a pilot to automatically release his bombs in predetermined quantity, mode and interval while freeing him to concentrate on flying is now possible with a solid-state electronic system developed by The Bendix Corp. The firm's Eclipse-Pioneer Div. at Teterboro, N.J. is producing these systems—called the Bendix Aircraft Weapons Release Set—for the Navy. A cockpit-mounted controller and a remotely located programmer comprise the system. The pilot has 11 combinations of stored release in quantities of two to six bombs in steps of one at a time, 8 or 20 in steps of four, and 20 to 40 in steps of 10. A control allows him to select any interval in the ripple mode from 20 to 2,000 milliseconds. A rotary switch allows the pilot any of six modes—singles, pairs or salvos in the step mode and the same in the ripple mode.

MATERIALS

Gelatin Laminate System Developed

Hughes Aircraft Co. has developed a system for expandable gelatin space structures that can be inflated and hardened to form permanent hardware. The firm reports that while gelatin is useless as a structural laminating resin on Earth because it absorbs water and softens, gelatin-glass fiber laminates are superior to many conventional laminating resins in a dry environment. An additional feature is the property of reversibility, which permits such a structure to be inflated, hardened and completely tested on Earth, then re-softened for packaging and deployment in space. This can be accomplished as many times as necessary by absorption or removal of moisture. None of the other systems has this property. Use of gelatin for space structures originally was suggested by researchers at Wright-Patterson AFB.

Picatinny Issues Plastics Compilation

More than 550 papers given at 23 conferences between March, 1964, and March, 1965, on plastics have been coded, abstracted and issued as PLASTEC Report 21. The subject index allows literature researchers to pinpoint materials, processes or applications. Titled "Subject Index, Bibliography and Code Description of Technical Conference on Plastics," the annual review is available for $2.50 from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151 (Report No. AD 620 142).

SPACE MEDICINE

Lockheed Reads EKG By Computer

Lockheed's Bioastronautics Laboratory has developed a computerized method to read electrocardiograms that has compared well with the judgments of a group of physicians. The computerized diagnostic system, which grew out of work on the problems of monitoring the health of astronauts, is able to analyze the electrocardiogram and make a judgment on whether the heart is abnormal or normal in 15 seconds. Lockheed points out that the technique would have application in mass screening of populations for potential heart problems as well as for astronaut monitoring.

Chronic 2-g Exposure Tested

Researchers at the Air Force School of Aerospace Medicine, San Antonio, Tex., who exposed mice to a constant environment of 2 g's for 10 or 11 days have found the experience resulted in adaptations that affected neurological response in some animals, but which were not necessarily detrimental. The acceleration—the kind that might be experienced on a long space journey to the planets—did not produce hemorrhages or lesions, but increases in heart weight, decreases in the weight of the spleen and reduced body weight were noted. In addition, there was no increase in seizures, which the scientists were encouraged to learn.

New Post-1970 Missions Investigated

Systems envisioned in NASA study contract to be awarded soon include a three-man LEM, an LLV and a three-man roving lab

by Willard E. Wilks

LOS ANGELES—Possibility of inserting a new phase into the postulated NASA schedule of lunar exploration beyond 1970 will be investigated in a MIMOSA study contract to be awarded soon.

The mission modes and systems analysis will cover the entire lunar exploration spectrum from 1970 on, David Paul III, of NASA's Marshall Space Flight Center, told MISSILES AND ROCKETS at the Society of Automotive Engineers' Aeronautic and Space Engineering/Manufacturing recent meeting here.

About a year after the MIMOSA study, NASA expects to be in a better position to decide how to proceed beyond *Apollo* Applications, knowing much more about all of the ramifications and interactions of lunar exploration, says Paul.

The specific post-AA proposal to be investigated in the MIMOSA study calls for a three-man Lunar Excursion Module (LEM) for personnel transport, and use of an unmanned lunar logistics vehicle (LLV) to deliver a three-man roving laboratory.

This is based on the assumption that the U.S. will find it desirable to extend its lunar effort beyond the reconnaissance and early exploration phase. With an increased emphasis on scientific mission planning and with most authorities agreeing that manned planetary landing or stop-over missions are many years away, probably in the 1980's, "a substantial lunar program appears feasible within current budget restraints," Paul said.

He said that while the AA program will make important contributions, its "limited scope" precludes development of a more effective personnel transport system, and the lunar surface operations will be relatively inefficient and somewhat limited by the need to abandon one astronaut in lunar orbit during the mission's surface exploration phase. "The additional risks associated with this scheme may become intolerable for surface missions beyond 14 days," he said.

Paul also pointed out that while the AA program will have developed a rudimentary LEM shelter at relatively minor effort, it has no inherent growth potential for extending surface stay-time beyond a week or two.

"Aside from the unmanned landing practice we will have added little to our basic capability. The shelter is marginal, at best, as a laboratory, and not conducive to extended, ambitious scientific endeavors. Neither will we have developed a logistics system," he said. "The LEM and/or the LEM shelter are necessary payloads on the LEM landing stage and provide critical flight-control functions to the combination. This feature precludes independent utilization of the landing stage for alternate payloads."

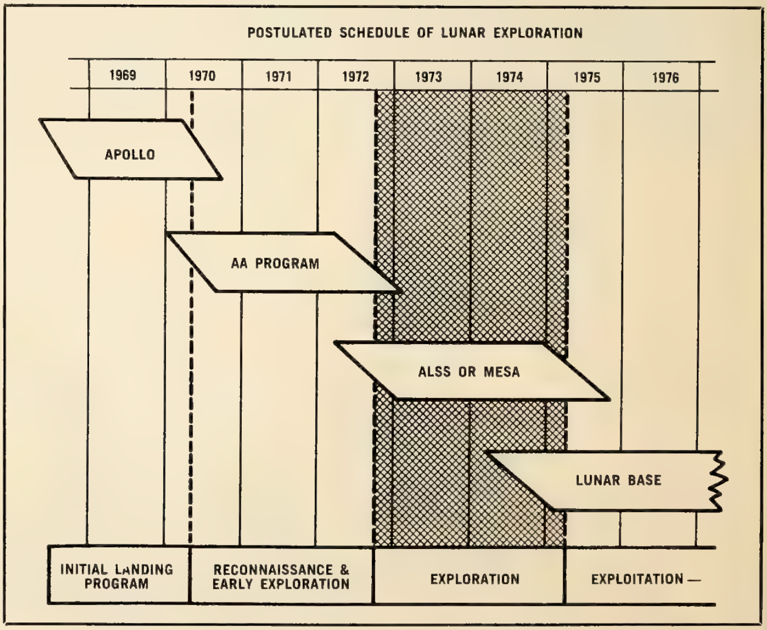
This situation makes it appropriate to set as systems improvement goals for the immediate post-AA period the development of a logistics delivery system and a personnel transport mode with significantly increased capability.

● **Crew transport possibilities**—Discussing the alternate approaches available for the crew transport, Paul said the first alternate would be continuation of the *Apollo*/AA concept, but that this appeared undesirable because penalties associated with leaving one man in orbit seriously limit the mission duration of any concept employing this mode.

A second alternative would be a nominal improvement in capability, retrofitting the LEM to transport all three astronauts to the surface, and modifying the Command and Service Modules to permit unattended orbital storage and orbit preservation. This would require a non-cooperating rendezvous by the LEM.

Other alternatives, including a three-man direct flight, appear to be major developments for the immediate post-AA period.

Paul said two logistics concepts also will be offered to the post-AA planner.



One is development of the LEM truck logistics system. However, "an obviously deleterious operation associated with LEM truck concepts is the need to commit a costly and more complicated manned flight to deliver supplies," he said. "The need for an *Apollo*-like operational sequence also has a second-order effect in that it restricts the envelope of the payload to the constraints of the LEM adapter section."

Another alternate logistics concept is the LLV, which would be designed for an unmanned direct flight and use cryogenic braking and landing stages. This could be sized to use the full potential of the *Saturn V* launch vehicle, having the entire 260-in.-dia. of the S-IVB stage available for payload.

- **AA limitations**—Paul said the AA program will demonstrate feasibility of many facets of fixed-base operations, but that the "rudimentary mobility afforded the AA scientist-astronaut will not satisfy his desire for sufficient 'ground truth' data."

Considering scientific mission objectives for lunar exploration and the nation's spaceflight posture after a successful AA program, "It appears that an equipment concept for the immediate post-AA time frame would logically consist of a significant mobility system and would emphasize field exploration."

This would rule out the mobile laboratory (MOLAB) concept associated with the *Apollo* Logistic Support System (ALSS) in favor of a mobile explorer or MOBEX concept, Paul said, pointing out that ALSS is limited in duration by both the payload capability of the LEM truck and the need to leave one astronaut in lunar orbit.

A vehicle such as MOBEX would be desirable since its capability could enable its use first in early and extensive geoscientific exploration and then in later fixed scientific station operation, according to Paul.

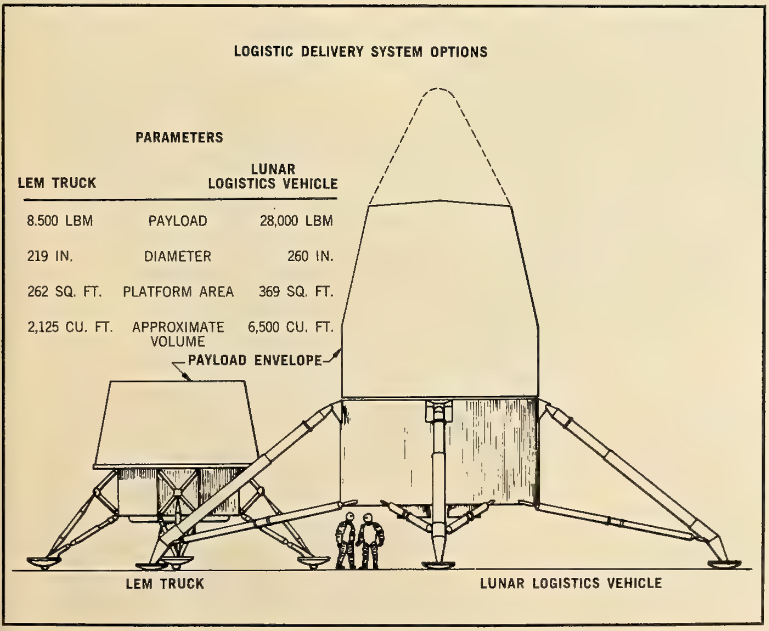
- **The best way**—Paul designated his approach as the Mobile Exploration System for *Apollo* (MESA) concept, requiring two *Saturn V* launch vehicles, an *Apollo* spacecraft with a three-man LEM capability, an LLV, and the MOBEX roving vehicle. In addition to providing significantly upgraded mission capability, it is conceivable the MOBEX vehicle could be de-activated upon completion of a mission and re-activated by a new crew for additional use.

Paul said the ALSS and MESA concepts would be quite competitive in operational costs and that it is most probable that the development costs for both the MOLAB and the larger MOBEX would be essentially identical. The LLV must be developed under the MESA concept, and this would cost substantially more than the LEM truck, with more development time required.

However, he added, "if scientific productivity is considered, it can be shown that the MESA mission is significantly more effective than an ALSS mission, with ALSS providing 28 man-days of exploration per mission, against 90-135 man-days for MESA.

"This is over 300% more effective than the ALSS concept. If the possibility of re-use of the MOBEX vehicle for a second MESA mission is exploited, the cost savings and effectiveness are even more spectacular. A minimum of 60 man-days per *Saturn* launch could be achieved—more than four times more effective than the ALSS concept."

MOLAB (MOBILE LABORATORY)		MOBEX (MOBILE EXPLORER)
2 MEN	CREW	3 MEN
14 DAYS	MISSION DURATION	30 TO 45 DAYS
250 MI.	VEHICLE RANGE	500-750 MI.
10 MPH	MAXIMUM SPEED	10 MPH



LOGISTIC DELIVERY SYSTEM OPTIONS

PARAMETERS

LEM TRUCK		LUNAR LOGISTICS VEHICLE
8.500 LBM	PAYLOAD	28,000 LBM
219 IN.	DIAMETER	260 IN.
262 SQ. FT.	PLATFORM AREA	369 SQ. FT.
2,125 CU. FT.	APPROXIMATE VOLUME	6,500 CU. FT.

If the MESA concept is chosen as the step beyond AA, the technologies and major systems developed for it will be directly applicable to the lunar base and could evolve without difficulty into fixed-base operations, Paul reported, with a main shelter system the only major item needing development.

- **Permanency sought**—Paul said his argument was based on the premise that a "phased commitment of resources leading to an eventual quasi-permanent lunar scientific station" is desirable.

Arguments concerning the validity of this basic premise and the desire to examine results of earlier programs before committing national resources to a significant lunar exploration and exploitation program can only be met by stressing three points, Paul says:

—The MESA approach provides a phased commitment by paying a minor development cost premium early in the program—a premium that could return substantial dividends if the lunar base is finally authorized.

—The approach, due to an estimated improvement in cost effectiveness, would for equivalent dollar expenditures (operational plus development costs) provide a higher productivity of scientific investigations.

—In the event an extensive lunar scientific station is not authorized, the MESA concept will still provide the most capable means to fulfill the desires of any restricted-scope program.

Paul said his discussion considered the future lunar exploration program from the standpoint of the mission planner and concluded that to be responsive to the desire to obtain the greatest return on the spaceflight investments, longer-range objectives must be reflected in concept selection decisions.

Paul, project engineer in the Lunar Systems Group, Advanced Systems Office at Marshall, detailed the MESA concept in a discussion on "The Challenge of Alternate Approaches to The Achievement of Lunar Exploration and Exploitation."

It is time to begin consideration of alternatives, he said, since long development leadtimes require that decisions initiating the next phase of the program must be made before the final results of the current program are available. ■

Hardened Antennas Pose Problems

Materials selection cited as major obstacle in designing microwave systems to withstand high-yield nuclear blasts

by John F. Judge

APPROPRIATE MATERIALS selection is proving to be the major problem associated with the design of hardened microwave antennas—capable of operating after exposure to high-yield thermonuclear blasts.

Malcolm A. Stephens, Martin Co. Orlando, Fla., Div. says the successful design of such an antenna involves solution of pressures in the environment as well as blast and shock loadings, and nuclear and thermal radiation.

"When the actual design is undertaken," he says, "many of these problem areas really resolve into the task of appropriate materials selection."

The hardened antenna program at Martin/Orlando is under contracts with the Air Force's Rome Air Development Center (M/R, July 5, p. 33). The antenna design consists of a dome-shaped structure some 31 ft. high with more than two-thirds of the unit buried. The radiating element is located in the ceiling of a sloping tunnel cut through the exposed portion of the dome.

● **Materials range**—Stephens says the materials considered ran from basic structural materials such as concrete and asphalt, through metallics and dielectrics up into plastics and ablators.

The Martin expert detailed the materials portion of the effort to the recent Mohawk Valley Communications Symposium of the Institute of Electronic and Electrical Engineers at Utica, N.Y. Since the program was limited to surface bursts, data developed were valid in atmospheric conditions.

The whole program was designed to determine materials and materials systems that could be used with confidence in fabricating truly hardened antennas.

The nuclear environment was examined and the specific materials properties assuring survivability determined. Those materials offering promise were selected and then evaluated through testing.

The size of the problem and the time limits imposed in the program precluded the extensive use of tests as a mechanism for materials selection, says Stephens. An analytical study was used instead to establish survival parameters.

First, says Stephens, it was necessary to establish the nuclear environment for the yields and overpressures of interest. Initial studies indicated that up-to-date data on the nuclear environment was not concentrated in any one source—and data on close-in effects was generally unavailable.

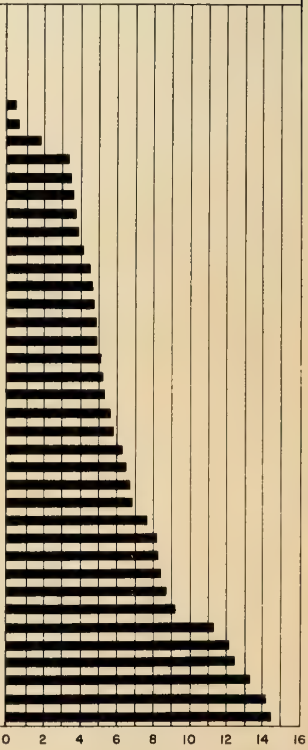
The Martin experts combed the U.S. Naval Ordnance Lab, White Oak, Md., and the Air Force Weapons Lab. A method for determining the thermal flux rate and the flux within the fireball was prepared using a combination of several analytical procedures.

● **Prime effects disclosed**—Air blast, nuclear radiation and thermal radiation were considered the critical effects parameters significantly affecting materials behavior. The primary criterion for material selection was the material's ability to withstand the thermal environment with little or no changes in electrical characteristics. Thus, says Stephens, most of the eligible systems ended up being either refractories or ablators.

Since the most significant survival parameter was that concerned with thermal flux, one of the first screening

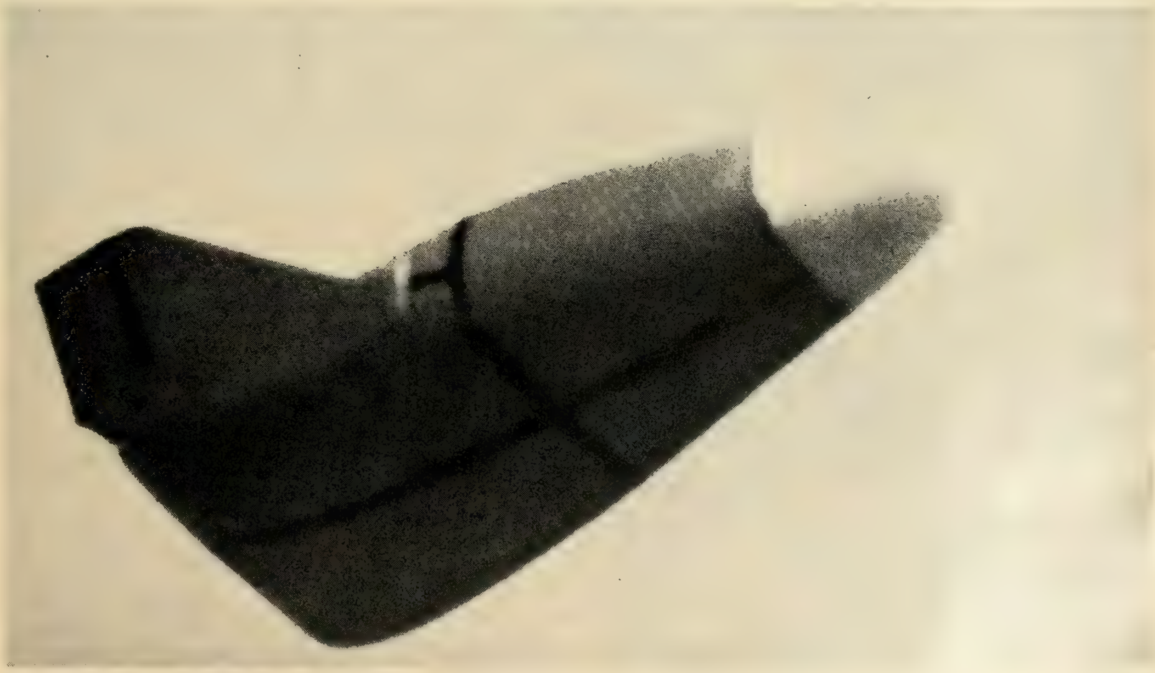
THERMAL recession rates tabulated by Stephens' group from exposures to Southwest Research Institute's arc image furnace.

MATERIAL	SPECIMEN NUMBER	RECESSION RATE μ-IN-BTU^{-1}-FT^2-SEC	SPECIFIC RECESSION RATE MICRO-INCHES PER BTU-FT^{-2}-SEC^{-1}
BORON NITRIDE	37	0.0	
BERYLLIUM OXIDE	29	0.0	
TUNGSTEN-MOLYBDENUM	38	0.0	
TUNGSTEN-SILVER	39	0.0	
TUNGSTEN-COPPER	42	0.0	
TITANIUM-NITROGEN-BORON	41	0.43	
MAGNESIUM OXIDE	27	0.54	
GLASS SILICONE	8	1.99	
RTV-SILICONE-MgO	16	3.32	
FOAMED SiC-POLYETHYLENE	35	3.54	
ASBESTOS-SILICONE-MgO	3	3.56	
CARBON-TEFLON	9	3.76	
ASBESTOS-SILICONE	2	3.90	
RTV-SILICONE	15	4.10	
EPOXY-NOVALAC-QUARTZ	19	4.61	
ASBESTOS-PHENYL-SILANE-MgO	5	4.70	
SILICA-FLAKE PHENOLIC	22	4.75	
PHENOLIC CORK	20	4.91	
GLASS EPOXY	12	4.93	
GLASS EPOXY 101	13	5.08	
MICA-FLAKE PHENOLIC	21	5.25	
ASBESTOS-PHENYL-SILANE	4	5.27	
FOAMED SiO$_2$-POLYETHYLENE	36	5.73	
POLYBENZIMIDEAZOLE	6	5.90	
GRAPHITE-TEFLON	11	6.28	
FUSED SILICA (MASROCK)	23	6.48	
ASBESTOS-EPOXY-SILICA	14	6.76	
ASBESTOS-PHENOLIC	1	6.81	
SILICA TEFLON	10	7.86	
DUROID 5650	7	8.14	
ZIRCONIA	28	8.30	
ALUMINA	30	8.41	
FUSED SILICA (CASTABLE)	24	8.71	
STEATITE	25	9.23	
FORSTERITE	26	11.40	
ASPHALT 13.5% CONCRETE	18	12.20	
M. I. CONCRETE	31	12.59	
GUSS ASPHALT	17	13.44	
VOLCANIC ASH CONCRETE	32	14.30	
STAINLESS STEEL (18-8)	40	14.55	



Continued progress in space requires a vehicle that maneuvers from orbit through hypersonic reentry to precision landing at any jet airport in the United States.

Creative engineering at Martin is making it happen.



PRIME lifting body, a step toward this goal, is scheduled for Air Force flight tests in space next year.

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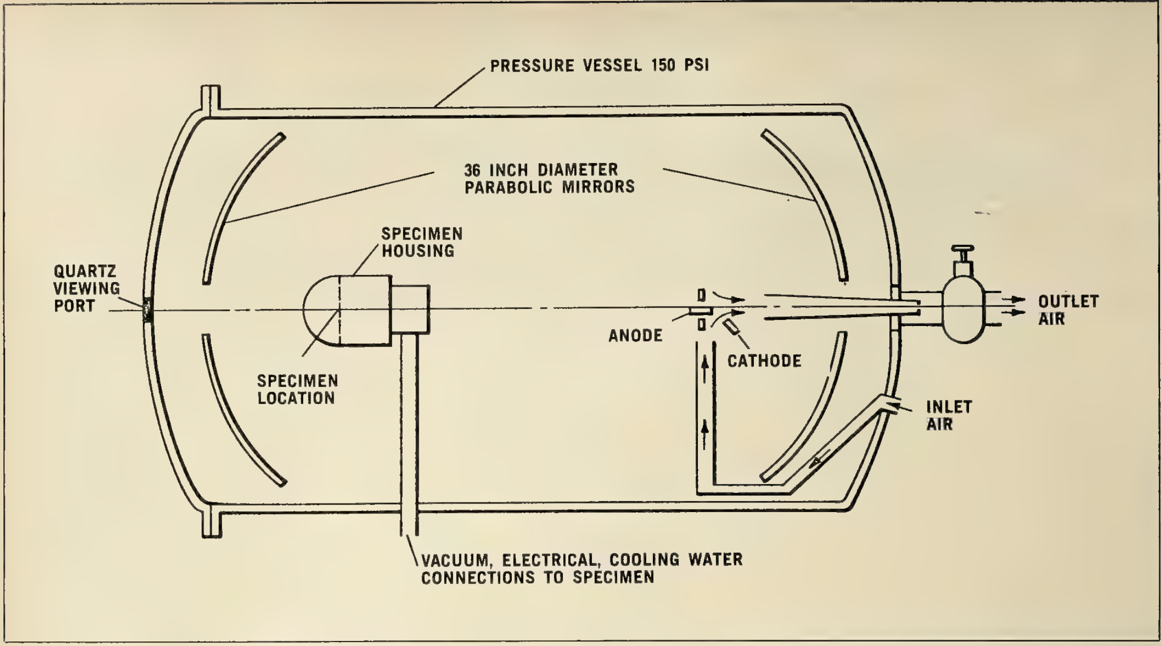


ARC IMAGE furnace schematic shows specimen position. Power supply to the 10-sec. arc consisted of a 450-kw, three-phase, full-wave-phase controlled rectifier. Spectral characteristics of arc closely parallel those of a nuclear blast.

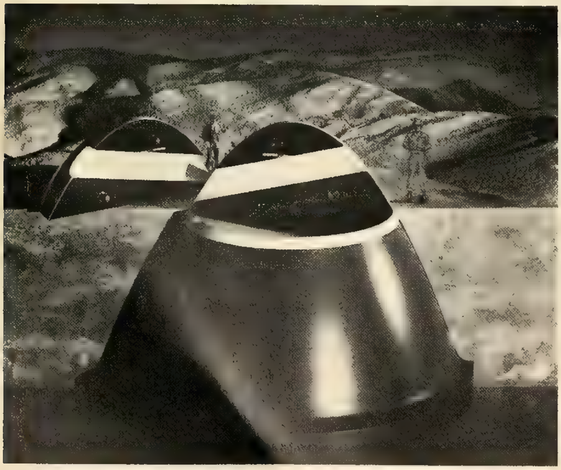
functions involved testing at high radiant temperatures. Other screening factors included nuclear radiation resistance, electrical properties, costs and availability.

Studies of test facilities were carried out concurrently with the materials properties investigation. The result was the choice of a pressurized arc image furnace, a pulsed nuclear reactor and a steady-state nuclear reactor for the evaluation portion of the program.

The arc image furnace used was the unit at Southwest Research Institute, San Antonio, Tex. This furnace provided a radiant heat flux of 1,000 calories/sq. cm./sec. Arc duration at this level was 10 sec. and material sample size was a 0.5-in. cube.

The pulsed reactor involved was the Sandia pulsed reactor at Albuquerque, N.M. This reactor is an unreflected, metallic uranium unit similar to the Los Alamos Godiva II. Since the reactor can be lowered into a shielded pit when not in operation, the area could be entered 30 min. after a supercritical burst.

A standard burst produces a 110°C temperature rise in the fuel material and yields 2 x 10^{16} fissions. The radiation at the closest point of experimental approach was 2.7 x 10^{17} neutrons/sq. cm./sec. peak flux and 6 x 10^{7} rads (water)/sec. from gammas at peak.



MODEL of hardened microwave antenna with top portion cut away to show angled tunnel arrangement.

Specimens exposed to the pulsed reactor were further exposed to a steady state reactor. The unit chosen was the ground test reactor at General Dynamics, Fort Worth, Tex.

This unit is a heterogeneous, highly enriched thermal reactor with a maximum power rating of 3 Mw. Water is used as the shielding, neutron moderator, reflector and coolant medium.

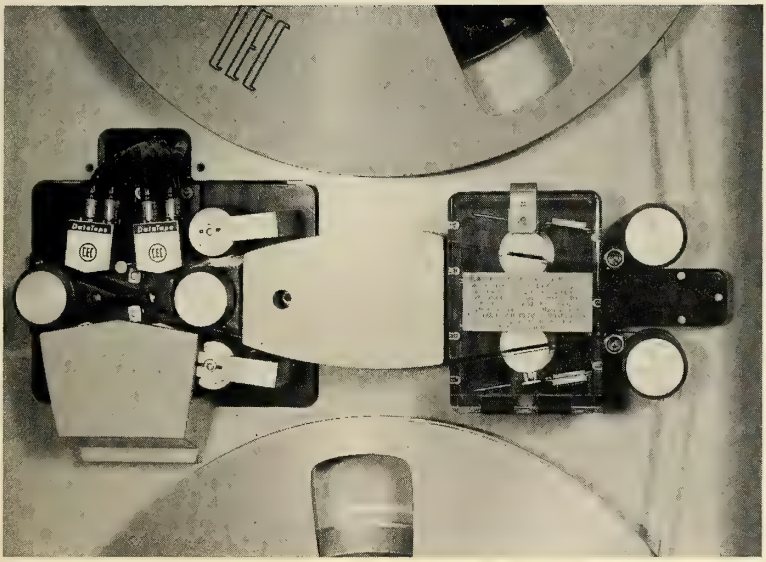
- **End-use governs**—The overall task of selecting materials was governed by certain key characteristics. For example, says Stephens, materials with high reflectance and emittance were desired since reflectance is particularly important in reducing the effects of thermal radiation, and high emittance is important in re-radiating heat from a structure. Many other characteristics were evaluated in compiling the list of applicable materials.

Each sample exposed in the tests had its properties determined before any dynamic experimentation in the thermal or radiative environments.

The chart of thermal recession rates derived from acquired data shows several materials with rates per unit of heat input of zero. (The units are microinches per BTU/sq. ft./sec.) Other materials had rates varying from 0.43 to 4.55 microinches per BTU/sq. ft./sec.

Stephens says the lowest material on the list, stainless steel, had such a low thermal conductivity that it melted rapidly under the thermal flux. Most construction materials exhibited a rapid

CEC's VR-3600 establishes new record for head life



It is not news that the VR-3600 is the most advanced of all magnetic tape recorder/reproducers. This has been proved in countless telemetry and laboratory applications. But what *is* news, is the remarkable durability of the instrument's recording heads.

All reports have shown that CEC's head life guarantee of 1000 hours is not only realistic but very conservative, since in virtually every case the new recording heads have surpassed this figure with little sign of wear. Compare the 1000 hour achievement with the performance of the VR-3600's closest competitor, and the savings to the user become significant indeed.

Reason behind the performance: these CEC recording heads are of a unique material and solid metal pole-tip design which completely eliminates the weaknesses of conventional head lamination or other solid-tip designs.

Result: a head that both provides superior performance at frequencies to 1.5 mc and reduces head wear and cleaning to a minimum.

Other advantages of the VR-3600 include . . .

1. **Bandwidth switchability.** With a mere flick of a switch, the operator may instantly change from wideband to narrow band, and back again—thus *doubling* the unit's capability with *no change* of components required. (On special order.)
2. **Constant flux recording** for assured machine-to-machine compatibility at all frequencies and tape speeds (with IRIG standards).
3. **Six speed switchable video FM**—d-c to 500 kc.
4. **Single source responsibility.** All components are designed and manufactured by CEC . . . including the video FM!

Important features:

▣ Pushbutton selection of *six* transport speeds along with associated electronics.

▣ Each of the VR-3600's 7 or 14 record/reproduce channels can be used for data storage in the 400 cps to 1.5 mc or d-c to 500 kc frequency range.

▣ Automatic end-of-reel sensing stops tape without leaders; transfer switch provides start command for nearby recorder and 30 second overlap of recorded data between machines—at no extra cost.

▣ IRIG or 18.24 kc AM servo system or time expansion/contraction servo system using common assemblies mean low cost for any version or combination of servo systems.

▣ Tape is constantly cleaned by optional vacuum/ionization; tension controlled, in all modes, by closed-loop servo control.

▣ Individual plug-in equalizers (6 per amplifier) meet all specifications simultaneously. Buy only those required, then set and forget.

▣ Record and reproduce amplifiers are solid state; the direct system fully amplitude- and phase-equalized.

▣ Tape transport skew is less than 0.5 μsec; complete cumulative flutter less than 0.30% p-p at 120 ips.

▣ The system may be supplied in single or dual rack configurations, with or without a dolly.

For *all* the facts about the VR-3600, call CEC or write for Bulletin 3600-X21.

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recession rate while others, such as the RTV silicones and asbestos-phenylsilane with MgO, looked promising.

Stephens cautions that the proper selection of material for hardened antennas involves many factors, and, while the data developed during the program at Martin/Orlando shows promise, it must be used judiciously.

It does indicate such things as structural materials like concrete should be protected by an ablator if they are to be exposed to the direct effects of a nuclear blast.

Specifically, says Stephens, the thermal tests indicated that ceramics such as boron nitride and beryllium oxide showed the best performance. Following these were the refractory metals and intermetallics.

In reviewing the performance of the plastic composites, the silicone-resin-reinforced laminates looked best. One surprise, says Stephens, was the good performance of carbon-cloth-reinforced Teflon. It was equal to the silicone-resin laminates.

- **Nuclear results**—The results of the nuclear radiation tests indicate a majority of the selected materials could be used for antenna hardening applications, but the peculiarities of specific material behavior under radiation must be taken into account and allowed for in any design.

The filled Teflons degraded significantly during the pulsed reactor tests—losing up to 80% of their strength. One of the most significant changes took place in concrete. Stephens says that after irradiation in the pulsed reactor the magnetite-ilmenite concrete lost approximately 50% of its compressive strength and the volcano aggregate concrete lost 20% of its compressive strength.

The silicones showed increases in tensile strength of 100% and increases in compressive strength of 3,600%, but with complete loss of ductility.

Radiation effects on electrical properties were minimal. The effect of neutron flux on certain materials was evident but varied. There were divergent results.

For instance, when Duroid was exposed to the pulsed and steady state reactors, the dielectric constant decreased. But when this material was exposed to the same integrated flux in a steady state reactor alone, the dielectric constant increased. The loss tangents experienced using Duroid underwent the reverse behavior.

In the case of polybenzimideazole, both dielectric constant and loss tangent decreased under high neutron flux rates but increased in the steady state reactor. The mechanical properties of most ceramics and metals showed little or no change under radiation. ■

oceanology

North American Sets Up Ocean Systems Facility

A NEW OCEAN Systems facility drawing heavily on experience in space work has been established at Santa Ana, Calif., by North American Aviation, Inc.

Within operating distance of the ocean, where open water testing is carried out between Seal Beach and San Clemente Island, the basic plant has been in existence for some time, serving initially as a marine ordnance laboratory. Later, in order to broaden its scope, it was renamed the Ocean Warfare laboratory. Two weeks ago, after another 30,000 sq. ft. of space had been acquired, the name was changed again—to Ocean Systems.

It is already at work on a classified Navy program for research into vehicle applications for underwater weapons. Contracting offices are the Office of Naval Research, Naval Electronics Laboratory, Bureau of Weapons and Bureau of Ships.

Facility director C. E. Craigo says the new group is a spin-off from the corporation's Space & Information Systems Division, and is located with SISD "because of some of the advanced technology we can realize from our space efforts. In space systems there is knowhow about such things as first-time reliability, and there is a strong relation to underwater systems because of the necessity of operating outside the sensible atmosphere, along with more efficient structures and more efficient performance."

Recently appointed chief scientist of the facility is Dr. E. R. van Driest, internationally known for his research into boundary layer control and aerodynamic drag. The laboratory is expected to expand its work in use of boundary layer control through geometric shape to greatly decrease drag and noise in submersibles.

Significantly greater efficiency for aluminum and fiberglass vehicles has already been proven at the lab by use of boundary layer control, Craigo reported, and analysis shows that drag can be cut by more than 50%. Such a reduction correspondingly diminishes both noise from turbulence and vehicle power requirements. The latter reduction makes it possible to decrease noise even further.

- **Consider the dolphin**—One method of drag reduction has been to utilize vehicle shapes similar in general to those of the dolphin and other water animals. Earlier experiments showed that drag could be cut by equipping vessels with a compliant, or soft, skin. However, recent NAA work has demonstrated that—provided the proper geometric shape is selected—even greater efficiency can be accomplished from hard-skinned vehicles.

"Obviously," a spokesman said, "you can get better fabrication costs and greater reliability with hard skins."

Craigo noted that the laboratory had succeeded in developing shapes with reduced drag by exploiting its experience in aircraft testing. "The same things apply to underwater shapes, if you draw the right analogies. We control the pressure gradient to achieve less drag."

In addition to applications suggested by the obvious similarities between spacecraft and underwater vehicles, Craigo said NAA will take advantage of the similarity between submersibles and aerial missile systems in the area of computers and guidance.

Still more drag reduction may be achieved by using the pumping and blowing techniques developed for aircraft, Craigo reported. The laboratory uses wind tunnel research in its underwater vehicle design projects.

Major emphasis at the facility is on improving the overall efficiency of underwater vehicles. "The more efficiency you have, the less power needed, or the more speed obtainable, and the broader the field of application becomes," Craigo said. "We are also concerned here with sensors, signal processing and communications links relating to underwater vehicles, and doing in-house work on sonar transducers."

The lab has developed an ocean turbulence sensor that has measured eddy velocities of .112 to 1.12 in. in diameter. ■

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75-mile Space Antennas Under Study

NASA funds research on Orbiting Radio Astronomy Observatory by TRW Systems Group and University of Michigan team

by Rex Pay

REDONDO BEACH, CALIF.—NASA has funded studies of Earth-orbiting antennas that may extend up to 75 miles in diameter.

The giant space structures are expected to give previously unattainable information about galactic and extragalactic emissions below 1 mc.

A contract of about $100,000 has been awarded to TRW Systems Group for studies of methods of erecting large antennas or antenna arrays in space. The award was made after study of the company's proposal of a 6,000-ft. spinning net antenna that unreels from a small central hub.

A similar amount has been awarded to a University of Michigan group, under Professor F. T. Haddock, which will study the overall concept of extremely large antennas and come up with sample specifications for such a complex major satellite.

Closely associated with direction of the project at NASA Headquarters are Ernest Ott, Technical Assistant, Astronomy Programs, and Dr. Nancy Roman, NASA Chief Astronomer.

● **"A true facility"**—Basically, the studies are examining the concept of the Orbiting Radio Astronomy Observatory, which is not yet an approved project.

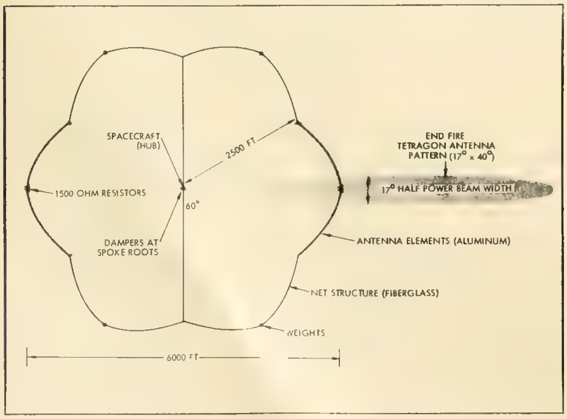
Ott emphasized that the word "Observatory" had been chosen with care. "In some cases we are prostituting this word," he said, "but to me an observatory is something like Mount Palomar where any scientist can go and make measurements—a true facility. This is what the *Orbiting Astronomical Observatory* is. ORAO would be the radio equivalent of this."

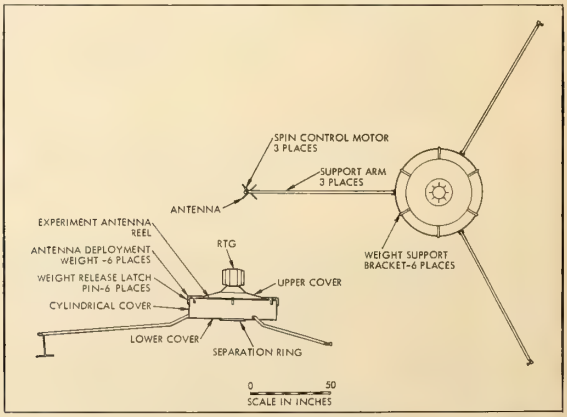
Both contracts run for between six months and a year and the aim is to look at many different configurations. To qualify for study, an antenna must be sensitive to radiations with frequencies less than 1 mc, down to frequencies of 50 kc. It should have a resolution adequate to resolve galactic and extra galactic structures—meaning beam widths of the order of degrees.

"There is no question that there will be a lot of scientific value from radio spectra below 10 mc," said Haddock. It will give information previously unattainable about radio sources, galactic structure, and quasars. He said that a 1-mc frequency had initially been chosen for the Michigan study because it is clearly a frequency low enough not to be received at ground level. However, it is still well above the frequency of interference that can be expected from the solar wind and solar corona.

● **400,000-ft. span**—The TRW studies will take a look at antenna structures suitable for frequencies down to 50 kc, which involves antennas 400,000 ft. across.

The TRW antenna proposed prior to the study-contract award was a spinning wheel whose spokes formed end-fire V antennas. A band of sky would be scanned once or twice per revolution, depending on whether one or two arrays were used. Chief material considered in the proposal was ¼-in. aluminum tapes 1 mil thick for the active spokes. Fiberglass would be used where


INITIAL CONFIGURATION studied by TRW Systems in ORAO proposal was 6,000-ft. tetragon used as end-fire antenna.
SPACECRAFT (HUB)
2500 FT
END FIRE TETRAGON ANTENNA PATTERN (17° x 40°)
1500 OHM RESISTORS
17° HALF POWER BEAM WIDTH
60°
DAMPERS AT SPOKE ROOTS
ANTENNA ELEMENTS (ALUMINUM)
NET STRUCTURE (FIBERGLASS)
WEIGHTS
6000 FT


BEFORE DEPLOYMENT, tetragon antenna is reeled up around central body of spacecraft. Spin motors power unreeling
SPIN CONTROL MOTOR 3 PLACES
SUPPORT ARM 3 PLACES
ANTENNA
EXPERIMENT ANTENNA REEL
RTG
ANTENNA DEPLOYMENT WEIGHT -6 PLACES
WEIGHT SUPPORT BRACKET-6 PLACES
WEIGHT RELEASE LATCH PIN-6 PLACES
UPPER COVER
CYLINDRICAL COVER
LOWER COVER
SEPARATION RING
0
50
SCALE IN INCHES

an insulating structure is required. The antenna itself would weigh less than 12 lbs.

Total weight of such a spacecraft would be 229 lbs. and its power consumption would be 17.6 watts. An *Atlas-Fire* booster could put it into a 400-by-80,000-mi. orbit and subsequent gravity-gradient precession would make the antenna scan the entire sky in six months.

Haddock said that antennas 10 km in diameter with beamwidths of the order of 10° were being studied initially. He thought that the continual rotation of the beam, if the antenna was spin-stabilized, would not pose a signal-strength problem. Although the antenna dwells for only a short time on a given area per scan, data from each scan can be stacked to enhance signal strength, provided the spacecraft's spin axis is not changing too rapidly.

"At low frequencies and at beamwidths of about 10°, the limit is not the sensitivity of the system," he said. "As I see it, the problem is the likelihood of multiple confusion of the number of sources."

The cosmic background is dominant, and there is no problem in mapping it. Measurement of individual sources, however, requires that they be isolated by the beam. With a 100-square-degree aperture there are some 400 independent beam positions. To map a source, some 20 beam positions per source would be needed. Thus there is the possibility of isolating about 20 brightest sources with the initial beamwidths being studied.

Another possibility being considered is the use of two antennas, widely spaced to act as an interferometer. The two would be orbited in a single launch —similar to the technique used for the *Vela* satellites.

● **Rotary nets**—In other studies funded by NASA's Office of Advanced Research and Technology, Astro Research, Santa Barbara, Calif., has designed spinning paraboloidal antennas a mile in diameter that can be given variable focus by applying tension to their rim.

Work there under Dr. Hans U. Schuerch has developed from a mathematical analysis of truss structures, such as spiders' webs and crystals, and has led to concepts for rotary decelerator nets as well as antennas. One antenna form would be made up of very fine filaments having preformed curves that would spring into shape on release from a launching canister.

The initial study on which TRW Systems made its proposal was designed for communications with ground stations like those in the 400-mc Goddard *Orbiting Geophysical Observatory (OGO)* system. A 6-watt solid-state transmitter already developed is expected to provide 3 kc of real-time analog data out to 100,000 n. mi. A command decoder would provide for 16 commands for turning the spacecraft operations on and off and for selecting the appropriate receiver frequency. An existing digital storage unit with a capacity of 10,000 bits would give data storage during eclipse.

● **Playing out tape**—The power system suggested by TRW is the SNAP-19 radioisotope generator under development for the *Nimbus* spacecraft. This would be mounted on the disc-like structure of the main ORAO spacecraft.

Three radial 10-ft. booms would provide leverage for a spin propulsion system used to deploy the net. The large antenna would be wound on a reel that is structurally a part of the spacecraft. Electronics and propellant tanks would be mounted inside the reel.

After separation from the final spinning solid-propellant stage of the launch vehicle, the spacecraft would receive a command to deploy its booms. The tapes would then be released and begin to pay out, assisted by weights on their ends.

The trick is to be able to play out extremely long lengths of tape without getting radial velocities that will snap the tape when it reaches the end of the reel.

This is done by using two tapes instead of one for each "spoke" of the wheel-like structure to be constructed.

Each pair of tapes is glued together with a pressure-sensitive adhesive that will allow the two to unpeel. The outer end of each tape is attached to its nearest neighbor on the next spoke. As the spin throws the tapes outwards, unpeeling of each pair starts at a certain point out along the spoke. Beyond this point the tape bends round to meet the tape from the next spoke, forming the rim of the antenna.

The net that is generated is initially star-shaped, with the re-entrant angles of the star at the point where the tapes are unpeeling from each other. As unreeling proceeds, the re-entrant angle grows more obtuse and the net begins to become more circular. The final periphery is a series of intersecting catenaries.

● **Adding margin**—The spin the spacecraft has after separation throws the tapes out a short way. Then a monopropellant propulsion system starts up to keep the spin going, adding the large margin of angular momentum that the final antenna has over the packaged configuration.

Use of the adhesive allows the engines to be fired at constant thrust, and the tapes reel out at a speed controlled chiefly by the force needed to unpeel them.

To stop the tapes winding themselves up again once they are out at full length, the propulsion system thrust is sized so that the torque it develops does not exceed the counter-torque developed by the spokes. Sizing of the propulsion system and the adhesive characteristics are critical.

● **Self-governing system**—Director of the study at TRW Systems is H. A. Lassen, director of unmanned spacecraft staff. He conceived the technique of absorbing radial energy by means of the pressure-sensitive adhesive, and a patent has been taken out in his name.

The great advantage of this deployment system is that no controls are required—it is self-governing. If two tapes happen to be stuck together too strongly, the angle between their unpeeled ends grows, reducing the tensile force needed to part them. The deployment configuration becomes slightly asymmetric but reels out in a stable way, claims TRW Systems.

To damp out gravity-gradient forces on the net and hub once the system is deployed, each spoke is attached to a short arm on the hub by means of a damper. This is expected to allow the system to be precessed by gravity-gradient forces in a stable manner.

Scale models of a six-spoke tetragon antenna were used to examine radiation patterns. A strong forward lobe was produced when two adjacent spokes were energized.

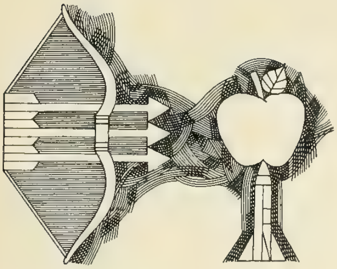
Analysis of a 19,000-ft-dia. net with a beamwidth of 8 by 20 degrees at 1 mc showed that 10 spokes were needed and an additional 150 lbs. of propellant was required, the total spacecraft weight rising to about 500 lbs.

● **Toward better utilization**—Manager for the systems studies at TRW, Robert A. Park, said that the V-antenna configuration originally proposed may not be the ultimate design chosen. At present, only half of the spacecraft diameter is being used, he pointed out, and better utilization might be possible.

The stability of the antenna pattern also requires analysis, he said. A random variation in the pattern could be really serious, but a known deviation from the expected pattern would be acceptable.

The signal-to-noise ratios that develop over the long antenna tapes will also be investigated. However, the gain of the antenna of the size being considered is such that quite large losses can be accepted.

A computer program has been developed to study deployment of the net, and this will be expanded to include distributed mass effects and take account of change of dynamic configuration with time. Extensive effort will be given to perturbation analysis of the deployment technique. ■



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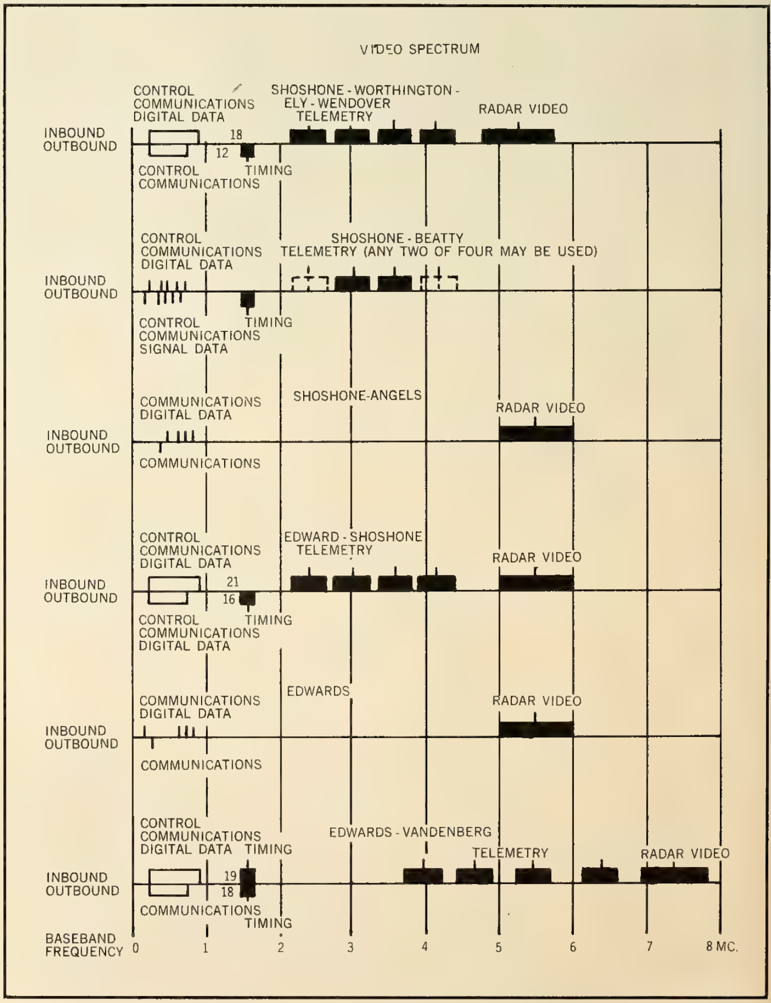
1,500-Mile-Long Data Corridor Nearly Ready

by Charles D. LaFond

CHICAGO—The final link in a 1,500-mile-long data acquisition and transmission system stretching from Wendover AFB, Utah, to Vandenberg AFB, Calif., will be completed within the next several weeks.

Solid-state microwave receiving and relay equipment developed by Motorola, Inc., for the nearly 400-mile final link connecting Edwards AFB, Calif., with Vandenberg is now undergoing Air Force acceptance tests, and installation

FREQUENCY distribution throughout full telemetry data collection and relay communications from Wendover AFB, Utah, to Vandenberg AFB, Calif.



will begin next week.

The completed system will provide an unmatched overland air corridor with means for handling telemetry and control data in real time during flight testing of advanced high-performance military aircraft. Already used for *X-15* rocket plane flight tests, it soon will be employed for XB-70 studies.

Total system cost approaches $4.5 million, including Motorola's present $700,000 contract for the final extension. The new circuits will be operational by the end of November.

Ultimately the system will be employed in inter-range operation with the Western Test Range and the Naval Ordnance Test Station at China Lake, Calif.

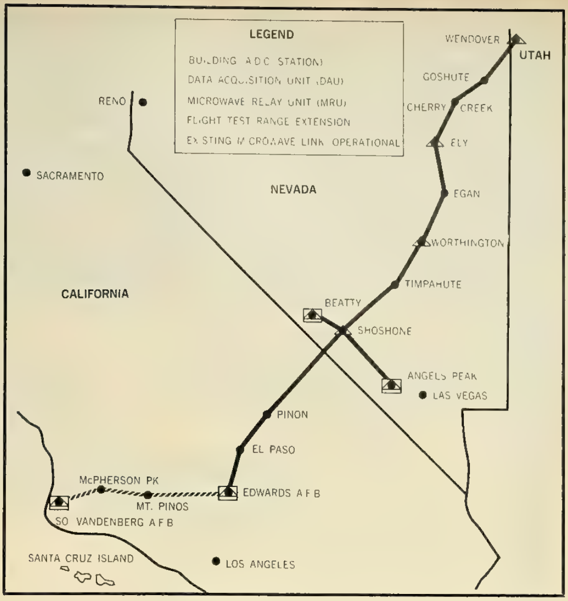
Two different site equipment combinations are employed (see map): the data acquisition unit (DAU) receives and re-transmits telemetry data; the microwave relay unit (MRU) serves as a repeater for data relay. Air Defense Command sites at Beatty, Nev., and Boron, Calif., can introduce search radar data into the system.

Other manned sites are located at Vandenberg; Edwards; Angels Peak, Nev.; Ely, Nev.; and Wendover, from which flight test data can be inserted.

System control normally is from Edwards, but could be transferred to Vandenberg for a particular mission.

- **System operation**—During operation, all data are received at the range

AIR FORCE Data Acquisition and Transmission System provides continuous real-time test data communications from Utah across southern California and into Pacific.



New Product of the Week:

Portable Radio Frequency Probe

A portable radio-frequency probe designed to detect latent defects in all types of electronic equipment is available from Honeywell, Inc.'s Minneapolis Aeronautical Div.

According to developers, the device offers significant benefits in three critical areas of system performance and maintenance: higher reliability, reduced checkout time and reduced maintenance costs.

The self-contained unit, under development at Honeywell for five years, is a broadband very-low-noise (less than 4 db) R-F amplifier that detects and measures noise in the 20 to 30-mc frequency range. It is center-tuned to 26 mc, a statistically proven noise peak. The unit consists of a pickup device, radio frequency and audio amplifiers, earphones, rechargeable batteries and cabling.

In operation, the operator scans the system being checked with a pickup device, an R-F probe. R-F noise levels in the equipment can be monitored by earphones; for detailed analysis, information can be transmitted to an oscilloscope or recording device. It is generally necessary to stimulate the noise in a suspected device by tapping it with a non-metallic rod and comparing the noise level with that of other devices, developers point out.

The system has been tested, with "impressive" results, on such equipment as the Air Force F-105 fighter-interceptor electronic systems, a television set, a digital computer, a gyro suspension assembly and a laboratory power supply.

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XP65-3

terminus building and directed to the test control facility, the master radar facility, and the NASA *X-15* control room at Edwards AFB. Because of the considerable data-reception redundancy inherent in the multiple-site system, signal-to-noise ratios of the air-to-ground transmissions are compared automatically and the best signal at any given time relayed to Edwards.

Sites are generally unattended and turn-on and control are directed from Edwards. Turn-on is handled sequentially outward until all stations are energized and stabilized. Control is by means of a tone-coding signal.

Eleven data channels include: four VHF wideband telemetry, one search-radar video or one PCM ($6x10^5$-bit capacity), one PCM ($8x10^5$-bit capacity), and five duplex digital radar. In addition, the system provides four channels of multiplexed 19-channel UHF air-to-ground voice communication plus range operation and maintenance voice channels as needed. Finally, a coded timing channel is available to provide 1-, 100-, or 1,000-pps signals.

(For additional system details, see M/R, Jan. 6, 1964, pp. 33-34.)

- **Microwave equipment**—A key element in Motorola's system-extension effort is the firm's MP-7 portable microwave communications set. Battery-powered (12-, 24-, or 48-volt supply), the solid-state design provides low power drain and small size. In addition, it offers unusual operational flexibility in that it can be used to handle conventional CCTV, radar relay, voice or digital transmission. With its 7-mc bandwidth, up to several hundred channels can be multiplexed and transmitted on a single carrier.

Set-up time, including frequency stabilization, can be accomplished within 15 minutes. Operating frequency is 7.1=8.4 gc.

The transmitter-receiver, measuring 17¼ x 10½ x 10½ in., weighs 37 lbs.; the power supply weighs another 22 lbs. and measures 17¼ x 5¼ x 10 in. Both front panels are designed for installation of 19-in. racks.

Developed by Motorola's Military Electronics Center in Chicago, the equipment, while designed for tactical military use, fits well into the Air Force telemetry data chain where the terrain varies from desert sand to rugged mountain tops and where wide temperature extremes are encountered daily.

Performance data obtained from the existing operational circuits indicate that demodulated signals at the Edwards station have been 35-45 db. above noise on a regular basis. This occurred regardless of the source point of the transmitted data. Further improvement is expected with the new equipment. ■

Circle No. 6 on Subscriber Service Card

space electronics

Fluidics Sensor

A pneumatic sensor, developed specifically for fluidics technology, has been announced by Fluidic Systems Div. of Raymond N. Auger & Co., Inc.

The "fluidic eye" can sense air streams or direct mechanical interruption of a short (approximately 0.5 in.) laminar sensing stream projected across its "sensing gap." Used as a limit switch, it responds to interruptions of its air stream of 0.001 in. while applying a pneumatic force on the sensed object of a small fraction of an ounce. It can sense interruptions of its sensing stream of a few millisecs. in duration and has no life limitation.

The device operates on less than 3/4 psi and produces an output of less than ½ psi. Consumption is less than 0.1 cfm.

Circle No. 152 on Subscriber Service Card

Rotary Attenuators

Texscan Corp. is marketing two miniature rotary atenuators for use in the d-c to 2,000-mc frequency range.

The Model RA-50 provides 0 to 10 db attenuation in 1-db steps with an additional step position for a 50-ohm line termination. The Model RA-51 provides 0-70 db in 10-db steps.

Other specifications include a VSWR of less than 1.21:1 at 1,000 mc and less than 1.5:1 at 1,500 mc. Accuracy is ±0.3 db at 500 mc and ±0.5 db at 1,500 mc. Insertion loss is 0.3 db at 1,000 mc; impedance is 50 ohms.

Circle No. 153 on Subscriber Service Card

Metals Tester

A portable eddy current instrument for testing and sorting ferrous and nonferrous parts has been developed by Forster/Hoover Electronics, Inc.

The Model QC-5000 Multitest "R" can be used to test materials and parts according to alloy composition, heat treatment, hardness, case depth, surface decarburization, tensile strength and ductility.

In operation, the instrument is adjusted to a test standard and a probe is placed on test parts, causing a meter needle deflection. When limits for sorting have been established, the testing procedure can be simplified by use of signal lights that automatically indicate sorting limits.

The device weighs 15 lbs. and measures 7 x 12 x 7 in.

Circle No. 154 on Subscriber Service Card

Power Supplies

Acopian Corp. is marketing a series of 700-ma dual-output regulated power supplies.

The plug-in units offer two identical or different voltages between 6 and 15v in 1-v increments. Each output may be adjusted ±1v either internally or remotely.

Other specifications include a load regulation of ±0.15% or ±0.3%, depending upon voltages selected. Line regulation is ±0.05%; ripple is 1 mv RMS.

Circle No. 155 on Subscriber Service Card

Spaceborne Memory System

A spaceborne memory system with an access time of 750 nanosecs. has been developed by Electronic Memories, Inc.

The device offers a storage capacity of 4,096 words of 32 bits each and operates at temperatures from –55° to 100°C. It meets MIL-E-5400, MIL-E-16400 and MIL-E-4158 specifications. Input is –5, 5 and 15v, 50 watts.

Circle No. 156 on Subscriber Service Card

Pressure Transducer

A miniature pressure transducer utilizing a three-fluted twisted bourdon tube pressure sensor has been announced by ElectroSyn Technology Laboratories.

The unit is submersible and effective for oceanographic and other underwater applications, the manufacturer said. It is particularly adaptable for use in process control, data logging and computer control systems.

According to the firm, an absence of rubbing parts in the signal generating device gives the unit a high level of reliability and extended sensing element service life. The 0 to 5-v dc output signal is compatible with existing telemetry control and test systems.

Circle No. 157 on Subscriber Service Card

Tracking Receiver

Canoga Electronics Corp. has developed a solid-state monopulse tracking receiver, the Model 3403.

The three-channel unit utilizes synchronous cross-correlation and phase-lock loop detection techniques for derivation of the d-c error voltage required to control the servo system of a tracking system.

The unit features full-accuracy angle tracking at 6-db signal-to-noise ratio at any bandwidth and 70-db dynamic range for all bandwidths. It meets NPC-200-3 and MIL-Q-9858 specifications.

Circle No. 158 on Subscriber Service Card

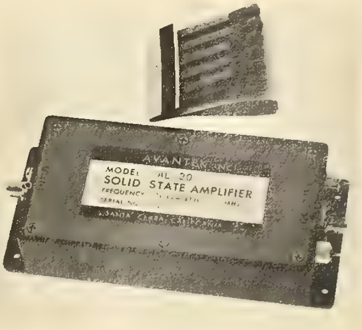
Solid-State Pre-Amplifier

A line of octave bandwidth R-F and I-F pre-amplifiers covering 100 to 1,000 MHz has been announced by Avantek, Inc.

The units are designed to operate between —54° and 100°C and will sustain 20 dbm of incident R-F power with degradation of performance. A militarized version provides 300,000-hr. MTBF and meets specifications of MIL-E-5400, MIL-E-5272, MIL-E-16400 and MIL-26600.

Maximum d-c input power is 0.5 watt at 15v dc. OSM-type miniature R-F connectors have an impedance of 50 ohms.

The Model AL-20 offers a 25-db linear gain with a flatness of 1 db over the 200 to 400 MHz frequency range. Minimum output is —5 dbm at saturation; guaranteed maximum noise figure is 3.5 db (2.5 typical).



Circle No. 159 on Subscriber Service Card

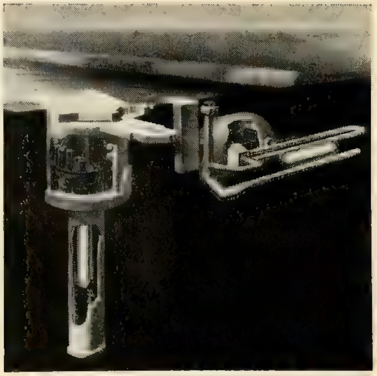
FIRST Minuteman II firing from an underground silo at Vandenberg AFB was a complete success. Minuteman II's nose cone splashed on target, some 5000 miles down the Western Test Range. U.S. Air Force's most advanced ICBM, Minuteman II has increased range, improved guidance, more flexible targeting and larger payload.

As Minuteman weapon system integrator, Boeing continues its responsibilities for assembly, installation, test, launch control and ground support equipment for Minuteman II. The first Minuteman II wing is now under construction at Grand Forks Air Force Base.

Minuteman is the nation's most cost-effective ICBM system. In going from drawing board to operational status in four years Minuteman set a new record in the design-development-production-delivery cycle of a major weapon system. Designed for simplicity, high reliability and ability to survive attack, Minuteman can remain on alert for long periods with minimum maintenance. Operation is from underground launch capsules, each manned by two Strategic Air Command officers. **Boeing Missile Division.**

Minuteman II

Underground, blast-resistant launcher. Contains missile and launch and targeting equipment. Connected to launch control center by multiple-channel communication system.



Launcher Equipment Building. Contains missile environmental control equipment.

The Industry Week

Mergers and Acquisitions

TRW, Inc., Cleveland, and McNeil Corp., Akron, have agreed in principle to merge. McNeil, formerly McNeil Machine and Engineering Corp., produces tire and tube vulcanizers, water-pumping, auto tune-up and materials-handling equipment and recreation products. It will become a TRW subsidiary. TRW also revealed that the directors of Clifford Motor Components Ltd. of England, a firm TRW offered to buy earlier, have recommended acceptance of the proposal to their stockholders.

New Activities

International Business Machines Corp.'s Federal Systems Div. has announced plans to establish a Space Systems Div. in Washington, D.C. Some 200 IBM personnel will be transferred to Washington from other IBM activities. The center would be responsible for developing the kinds of systems for space vehicles presently done at the company's Oswego, N.Y., location. A site for the new operation has not been determined, but it is possible that it will be headquartered at a 240,000-sq.-ft. building presently under construction in Gaithersburg, Md., where much of the remainder of the company's Washington-area activities will be consolidated. . . . *The Board of Directors of Hercules Powder Co., Wilmington, Del., has recommended to stockholders that the company's name be changed to Hercules, Inc., to present a less confined image of the company's activities. The Hercules Powder name would be retained by a subsidiary.*

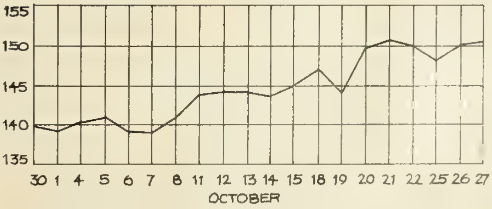
Facility Expansions

The Testing Div. of Wyle Laboratories has announced plans to expand its propellant testing facility in Norco, Calif. Principal addition will be a $25,000 administration building structurally linked to the facility's underground test control complex. . . . *The Electrada Corp. of Culver City, Calif., has leased, with options to buy, the physical assets of the former Astro Structures division of Lear Siegler, Inc., at El Segundo, Calif. Electrada is moving the operations of its Airtite Div. to the new facility from East Los Angeles. Airtite produces thin-wall pressure vessels for cryogenic fuels and positive expulsion systems for missiles and space vehicles. The new Airtite plant includes the largest spin-forging facility in the U.S., capable of producing aerospace metal structures up to 10 ft. in diameter. Newly created in the facility is a pressurized controlled-atmosphere welding area containing completely automatic Tungsten Inert Gas welding and electron beam welding equipment.* . . . Rebikoff Oceanics, Inc., supplier of underwater equipment and services, has moved from Chicago to Fort Lauderdale, Fla. Undersea services provided by Rebikoff include research, photography, special diving, training, search, exploration, charting, salvage, repair and construction. . . . *Anaconda Co. plans to build a multi-million-dollar research laboratory near Tucson, Ariz., to house offices and research and development facilities for the firm's Extractive Research and Metallurgical Div. The lab will be operated jointly with the University of Arizona. Construction of the 70-acre site is expected to begin next spring.* . . . Systems Engineering Laboratories, Inc., Fort Lauderdale, Fla., manufacturer of computer-controlled digital data systems has opened a new area office in Huntsville, Ala. . . . *C. G. Hokanson Co., Inc., Los Angeles, maker of ground support air conditioning equipment for aerospace, commercial and aircraft applications, has begun construction of manufacturing, research and office facilities in Santa Ana, Calif. Total floor space to be provided by the new building will be 90,000 sq. ft.*

SEC Clears ARC Stock Sale

The Securities Exchange Commission has cleared for sale a block of 659,162 shares of Atlantic Research Corp. stock held off the market since December, 1963. The SEC issued the stop order on the stock at that time to force full disclosure of company finances. Clearing of the registration for sale on the American and Philadelphia-Baltimore-Washington exchanges indicates SEC acceptance of the firm's most recent financial statements. Holders of the stock are American Potash & Chemical Corp., 29,000 shares; Atomics, Physics and Science Fund, Inc., 50,000; Television-Electronics Fund, Inc., 115,000; Arch C. Scurlock, former board chairman and former chief executive officer, 20,570; and Sloan Manufacturing Co., 43,592 shares. The remaining 401,000 shares belong to Scurlock and Sloan Manufacturing, but are otherwise pledged or subject to liens, according to the SEC. The financial statement that prompted the stop order in 1962 was found by the SEC to contain "materially defective" material. Found suspect were the description of the company's business, transactions by ARC in which certain management officials had a direct or indirect interest, potential disallowance of contract-cost recoveries, and estimated Federal income taxes.

Missile/Space Stock Index



100 = CLOSING PRICES OF 19 REPRESENTATIVE AEROSPACE FIRMS DEC. 31, 1964
STOCK PRICES FURNISHED BY MERRILL LYNCH, PIERCE, FENNER AND SMITH

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what's next, nasa?

MISSILES AND ROCKETS asked this probing question, "What's Next, NASA?" And on November 29, 1965, MISSILES AND ROCKETS will publish its Fifth Annual NASA Issue with answers to this question as well as an authoritative examination of the National Aeronautics and Space Administration's current and future projects and facilities.

After a year of spectacular achievement, including Astronaut White's record extravehicular space walk and Gemini 5's record 191 hours in space, NASA is looking ahead to its new space programs. Special emphasis is placed in this issue on the Apollo Applications Systems, which have an estimated total cost of over $1 billion, and project Voyager, which will explore Mars, Venus and other planets.

This special issue will also explore NASA's plans for other new projects as the U.S. space program begins its swing away from the exploration of the Moon to the vaster and more challenging mission of probing the planets.

MISSILES AND ROCKETS provides the recognized and authoritative route to reach the men who will be making the research, design, engineering and procurement decisions in these new multibillion-dollar programs.

BONUS CIRCULATION: By request, the fifth annual NASA issue of MISSILES AND ROCKETS will provide 5,000 bonus circulation to the decision-makers in Government, the Atomic Energy Commission, ComSat Corporation and the National Aeronautics and Space Administration.

Publication Date: November 29, 1965 *Closing Date: November 15, 1965*

American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Wash., D.C. 20005

missiles and rockets

THE WEEKLY OF ADVANCED TECHNOLOGY

AWARDS

AIR FORCE

$36,952,148—**Thiokol Chemical Corp.,** Bristol, Pa., to produce Stage I *Minuteman* motors.

$30,201,773—**Philco Corp.,** Philadelphia, Pa., for development and production of space re-entry measurement vehicles.

$10,000,000—**General Electric Co.,** New York, N.Y., to continue research and development work on the Mark 12 re-entry program.

$5,200,000—**Aerojet-General Corp.,** Sacramento, Calif., to make *Titan II* propulsion systems.

$4,972,355—**Marquardt Corp.,** Van Nuys, Calif., for continued work on a classified program.

$2,126,000—**Aerojet-General Corp.,** Sacramento, Calif., under an existing contract for Stage II test motors for *Minuteman* missile.

$2,030,368—**Lockheed Aircraft Corp.,** Burbank, Calif., to conduct missile site studies.

$1,939,058—**International Telephone & Telegraph,** Federal Electric subsidiary, Paramus, N.J., for 058 command and control communications equipment.

$1,719,630—**General Electric Co.,** New York, N.Y., to continue work on the *Nike-Zeus* anti-missile program.

$1,200,000—**Philco Corp.,** Philadelphia, Pa., to do fusing and arming tests and evaluate space re-entry vehicles.

$455,574—**Magnavox Co.,** Fort Wayne, Ind., for components of AN/ARC-34C radio set, aerospace ground equipment, spares and data.

$233,437—**Dow Chemical Co.,** Midland, Mich., for investigation of the thermodynamic properties and decomposition kinetics of propellant ingredients.

$204,012—**Avco/RAD,** Wilmington, Mass., two-year renewal to study radiation from high temperature arc-heated gases.

$99,500—**Massachusetts Institute of Technology,** Cambridge, for study of moving gravimeters and application of ballistic missile guidance technology to aerial gravimetry.

$98,986—**Clevite Corp.,** Electronic Research Div., Cleveland, for fabrication of cadmium sulfide thin-film solar cells for space vehicle testing.

$94,000—**Sylvania Electric Producers, Inc.,** Waltham, Mass., to design and develop electronic equipment that will track and photograph rocket sleds traveling at speeds of 4,000 miles per hour.

$78,875—**Academy for Interscience Methodology,** Chicago, Ill., for study of mid-course defense against ballistic missile attack.

$70,671—**Planning Research Corp.,** Los Angeles, for study of mixed defense against ballistic missile attack.

$68,500—**General Dynamic Corp.,** Convair Div., San Diego, Calif., for feasibility study, design and prototype fabrication of a contoured nozzle system for the 50-megawatt electrogas dynamics facility.

$27,980—**Space Data Corp.,** Phoenix, Ariz., for rocket motors with igniters.

ARMY

$16,212,624—**Hercules Powder Co.,** Wilmington, Del., for production of propellant powder for rockets.

$11,559,290—**Avco Corp.,** Stratford, Conn., for design, development, fabrication and test of gas turbine engines.

$1,805,337—**Radio Corp. of America,** New York, N.Y., continue research and development in Moorestown, N.J., on *SAM-D* missiles.

$1,304,160—**Technical Material Corp.,** Manaronect, N.Y., for radio transmitters.

$1,249,287—**Hughes Aircraft Co.,** Culver City, Calif., for continued research and development work on a surface-to-air missile project in Fullerton, Calif.

$1,059,345—**Varian Associates,** Palo Alto, Calif., for kylstron tubes for *Hawk* missile system.

$749,551—**B. B. McCormick & Sons, Inc.,** Jacksonville Beach, Fla., for surfacing and widening Launch Complex 39 crawlerway at Kennedy Space Center, Fla.

$613,530—**Intercontinental Manufacturing Co.,** Garland, Tex., for *Pershing* first- and second-stage rocket cases.

$333,602—**Brown Engineering,** Huntsville, Ala., for R & D for engineering studies, development analysis, program evaluation and illustrative work of the *Nike-X* missile system.

$310,000—**Westinghouse Electric Co.,** Baltimore, for splash detection and radar system for *Nike-X*.

$283,070—**Hayes International Corp.,** Birmingham, Ala., for industrial engineering services to support *Pershing* missile trainers.

$225,827—**Kaman Aircraft Corp.,** Bloomfield, Conn., for R&D study on warhead effects in support of *Nike-X* system.

$151,582—**Avco Corp.,** Research and Advanced Development Div., Wilmington, Mass., to fabricate, calibrate and flight-test ion spectrometer.

$150,000—**Stanford University,** Stanford, Calif., for modification for 12-month R&D study of linear decision techniques for discrimination in support of the *Nike-X* system.

$82,637—**Cutler-Hammer, Inc.,** Airborne Instrument Lab Div., Deer Park, N.Y., for continuation and expansion of theoretical analysis and special engineering analysis relative to typical foreign surface-to-air missile systems.

$63,518—**Avco Corp.,** Research and Advanced Development Div., Wilmington, Mass., for one-year study of laser induced surface effects.

$50,000—**North Carolina State University,** Raleigh, N.C., for 12-month research on nuclear energy laser system.

NAVY

$75,000,000—**Hercules Powder Co.,** Wilmington, Del., sub-contractors for the motor development of the *Poseidon* submarine-launched missile by Lockheed Aircraft Corp., Burbank, Calif.

$42,037,750—**Applied Science Industries, Inc.,** Falls Church, Va., for *Mighty Mouse* air-to-ground rocket components.

$14,000,000—**Thiokol Chemical Corp.,** Bristol, Pa., subcontractors for the motor development of the *Poseidon* submarine-launched missile to be built by Lockheed Aircraft Corp.

$4,903,155—**Johns Hopkins University,** Applied Physics Lab., Silver Spring, Md., from the Bureau of Naval Weapons amendment to continue research and development work on guided missile systems.

$4,885,912—**Johns Hopkins University,** Applied Physics Lab, Silver Spring, Md., contract modification for continued R&D on guided missile systems.

$1,301,625—**Canadian Industries, Ltd.,** Washington, D.C., for rocket propellant.

$900,000—**General Electric,** Syracuse, N.Y., for conformal/planar array sonar system.

$566,000—**Babcock Aerospace Div.,** Costa Mesa, Calif., for receiver-decoder units used for the remote control of aircraft-type missile target vehicles.

$481,707—**Cameron Iron Works, Inc.,** Houston, for guided missile metal parts assemblies.

NASA

$711,490—**Kahn and Co.,** Amityville, N.Y., from Kennedy Space Center for video equipment.

$395,875—**Lockheed Aircraft Corp.,** Missile & Space Co., Sunnyvale, Calif., from Lewis Research Center to provide aerospace ground equipment and services at Hangar E, Eastern Test Range to increase *Agena* vehicle checkout capability.

$363,000—**Foley Machinery Co.,** Union, N.J., from Goddard Space Flight Center for power plant system.

$157,524—**Stanford University,** Stanford, Calif., from Ames Research Center for research and advanced development of biological instrumentation devices.

$148,374—**Auburn University,** Auburn, Ala., from Marshall Space Flight Center for study of phase variation characteristics of very low frequency transmission.

$112,475—**King-Knight Co.,** San Francisco, Calif., from Goddard Space Flight Center for 250-kw uninterruptible power system.

$89,353—**Control Science Corp.,** Framingham, Mass., from Goddard Space Flight Center for microelectronic time decoder.

$83,510—**Vitro Corp. of America,** Vitro Labs., West Orange, N.J., from Kennedy Space Center for equipment and documentation for MILA timing system.

$74,900—**Cornell Aeronautical Lab.,** Buffalo, N.Y., from Goddard Space Flight Center for an investigation of the causes of the premature firing of the *Delta* X-258 motor on *OSO* program.

$66,000—**University of Wisconsin,** Madison, from Goddard Space Flight Center for spin scan camera system equipment for *Applications Technology Satellite.*

$60,900—**Conic Corp.,** San Diego, Calif., from Manned Spacecraft Center for solid state VHF telemetry transmitters to be used in the Lunar Excursion Module.

$60,000—**Quantic Industries,** San Carlos, Calif., from Ames Research Center for design and test of Earth aspect sensor.

$57,699—**Bendix Corp.,** Ann Arbor, Mich., from Marshall Space Flight Center for surface vehicle navigation system.

$57,638—**Minnesota Mining & Manufacturing Co.,** Camarrilo, Calif., from Lewis Research Center for record/reproduce system.

$53,814—**Philco Corp.,** Aeronutronic Div., Newport Beach, Calif., from Ames Research Center for study of a passive damper for atmosphere entry bodies.

$47,100—**Marshall Laboratories,** Torrance, Calif., from Goddard Space Flight Center for integration of experiment package for *OGO-E*.

$46,666—**Philco Corp.,** Western Div., Palo Alto, Calif., from Goddard Space Flight Center for star detector attitude reference experiment for *Applications Technology Satellite.*

$45,713—**Shell Oil Co.,** Shell Development Co., Emeryville, Calif., from Western Operations Office for theoretical analysis of the performance and properties of high-energy hydrocarbon booster fuels.

$39,605—**Dyna-Therm Corp.,** Los Angeles, Calif., from Ames Research Center for thermal control coatings system.

$37,670—**Space & Tactical Systems Corp.,** Burlington, Mass., from Goddard Space Center for power converters for the retarding potential analyze experiment for *OGO-E*.

$36,448—**Telement Co.,** Amityville, N.Y., from Kennedy Space Center for video equipment.

$35,000—**Hines Labs., Inc.,** San Francisco, Calif., from Ames Research Center for operation of habitable gas atmosphere exposure equipment.

INDUSTRY

$15,000,000—**Bendix Radio Div.,** Baltimore, from **Douglas Aircraft Co.,** Tulsa, Okla., in connection with *Apollo*/Range Instrumented Aircraft (A/RIA) program.

$733,500—**Straza Industries,** El Cajon, Calif., from **Hayes International Corp.,** Birmingham, Ala., for 50,000 pressure volume compensators for classified military use. Also $270,900 a supplemental contract for environmental and propellant lines for ground support systems in the *Saturn* missile program.

$352,000—**California General, Inc.,** Chula Vista, Calif., from **Arrowhead Products,** Los Alamitos, Calif., for Gimbal Tabs and Gimbal Rings on *Saturn* program.

PROCUREMENTS

REQUESTS FOR BIDS

Contracting Officer
National Aeronautics & Space Administration
Langley Station
Hampton, Va.

Endeavoring to negotiate a contract with Republic Aviation Corp., Farmingdale, Long Island, New York, for the development of a non-destructive, automatic technique for the monitoring and recording of fatigue crack growth. For information only; RFP not available.

Contracting Officer
National Aeronautics & Space Administration
Langley Station
Hampton, Va.

Endeavoring to negotiate a contract with United Technology Center, Div. of United Aircraft

Corp., Sunnyvale, Calif., covering an analytical and experimental study to determine the effect of spin on hybrid rocket internal ballistics. For information only; RFP not available.

Contracting Officer
National Aeronautice & Space Administration
Langley Station
Hampton, Va.

Endeavoring to negotiate a contract with the Missile and Space System Div., Douglas Aircraft Co., Inc., Santa Monica, Calif., for a study to determine the dynamic effects of crew motion in a manned orbital research laboratory. For information only; RFP not available.

Contracting Officer
National Aeronautics & Space Administration
Langley Station
Hampton, Va.

Negotiating a contract with Tempil Corp., New York, N.Y., for the conduct of a program to develop low temperature phase-change temperature indicators. For information only; RFP not available.

Air Force Missile Development Center
Procurement Directorate
Attn: MDMKN-4
Holloman Air Force Base, New Mexico 88330

Additional research and development work will be added to existing contract with Planning Research Corp., Los Angeles, Calif., for a study of area defense against ballistic missile attack, part B: PR RRR-66-R & D-3. For information only; RFP not available.

Bureau of Naval Weapons
Washington, D.C. 20630

Design and develop test instrumentation for the *Poseidon* missile program. Intends to solicit a quotation from Interstate Electronics Corp., Anaheim, Calif. For information only; RFP not available.

Bureau of Naval Weapons
Washington, D.C. 20630

Inertial reference integrating gyros for *Polaris* guidance systems. Intends to solicit quotations from Honeywell, Inc., St. Petersburg, Fla. and Nortronics, Norwood, Mass. For information only; RFP not available.

Commanding General
Army Missile Command
Redstone Arsenal, Ala.

The U.S. Army Missile Command proposes to procure power supply for the *Hawk* missile system IPD-02-253 ea.-RFT AMC(Z)01021-66-1761—submittal date, Nov. 8.

NASA
George C. Marshall Space Flight Center
Huntsville, Ala.

Computer system required for proposal 2-6-22-00418-01—bid opening Nov. 12, proposal sets are limited and will be furnished on a first-request, first-served basis until supply is exhausted. For copy of RFQ contact PR-FE Mr. T. A. Johnson, 842-3146.

NASA
Goddard Space Flight Center
T & DS Negotiation Section C
Code 248-3
Glenn Dale Road, Greenbelt, Md. 20771

Issued request for proposals to 47 firms for on-site space systems analysis and computer programming services PCN 77023-365. These services will involve theoretical and analytical studies, development, design, writing, testing and documentation of computer programs including the processing and analysis of data as required in support of scientific, communications, meteorological and related projects of Goddard SFC. Proposals are required at Goddard SFC, T & DS Negotiation Section C, Code 248-3 not later than the close of business on Nov. 19. May obtain a copy of the RFP upon written application to Mr. Ronald R. Dapice, Code 248-3, Goddard SFC, Greenbelt, Md., Area Code 301 982-4187.

Fort Monmouth Procurement Division
Procurement and Production Directorate
U.S. Army Electronics Command
Fort Monmouth, N.J. 07703

Award is being made to Hughes Aircraft Co., Communications Div., Fullerton, Calif., for continued work in the field of satellite communications under RFP AMC (S) 28-043-66-00369(N). For information only.

National Aeronautics and Space Administration
Marshall Space Flight Center
Huntsville, Alabama

NASA will negotiate with M. B. Associates, San Ramon, Calif., for a study to develop a micrometeoroid accelerator. For information only; RFQ not available.

National Aeronautics and Space Administration
Marshall Space Flight Center
Huntsville, Alabama

NASA will negotiate with Honeywell, Inc., Space and Armament System Aeronautical Div., Minneapolis, Minn., for a continuation of studies of man-system criteria for extraterrestrial surface roving vehicles. For information only; RFP not available.

National Aeronautics and Space Administration
Contracts Division
Washington, D.C. 20546

The space agency is negotiating with General Technologies Corp., Alexandria, Va., for research investigations leading to development of various composite materials for space vehicle structural applications. For information only; RFP not available.

New Career Opportunities at Marquardt

Experienced engineers with backgrounds in reaction control rocket technology and airbreathing propulsion are needed immediately for major assignments in Marquardt's

AEROSPACE EQUIPMENT DEPARTMENT

STRESS ANALYST. Perform stress analysis in support of design efforts. Includes plates, shells, rotating shaft elements, discs, blades, structural dynamics, vibration problems, tanks, and thermal stress. Requires directly applicable experience.

CONTROLS. Perform major non-linear analog computer studies of advanced pneumatic servo-mechanisms and space vehicle attitude control systems. IBM 7040 programming capability desired.

HEAT TRANSFER/THERMODYNAMICS. Conduct and direct analytical studies in heat transfer and thermodynamics in support of preliminary design of spacecraft propellant thermal protection systems and power systems. Requires a minimum 7 years experience in heat transfer and thermodynamic analysis. Cryogenic experience and M.S. preferred.

ENGINEERING ANALYST. Perform engineering analysis on mechanical, electro-mechanical and hydraulic systems and components. Includes valves, actuators, rotating machinery and tanks. Requires directly related analytical experience.

DESIGN. Achieve design efforts on mechanical equipment including hydraulic, pneumatic, and electro-mechanical. Should be willing to do both board and analytical design. Must have B.S. degree and 5 to 6 years applicable experience with an aerospace equipment or turbo machinery company.

Marquardt also has immediate openings in the following areas:

INSTRUMENTATION. Instrumentation systems and component design, development, research, analysis, and application to data acquisition on rocket engine test programs. Experience required in area of transducer and conditioning equipment application to meet specific measurements requirements in flow, pressure, temperature, force and vibration.

PERFORMANCE ANALYST. Systems performance analyses related to aeronautical propulsion. Integrate component experimental data into system performance from ground and flight test data. Requires 3 to 7 years broad missile and propulsion system experience including 1 or 2 years in ramjet propulsion.

All engineering positions require a minimum of two years experience and engineering degree.

Send resume, in confidence, to Professional Personnel Dept. G

THE Marquardt CORPORATION
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names in the news

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Ronald S. Gall: Named chairman of the New Jersey Aerospace Committee of the State Resource Development Council. The committee has been established to advance the position of the state in aviation and related fields.

C. E. Hunter: Elected to the executive committee of the National Security Industrial Assn. He is vice president and general manager of Thiokol's Wasatch Div.

Dr. George Marr: Named director of the systems analysis group for the Research and Computation Div. of Electronics Associates, Inc. The group will concentrate on expanding EAI's participation in industrial process computing.

Robert H. Farwell: Appointed manager of the *Applications Technology Satellites* Transportable Ground Station (ATS/TGS) program for Sylvania Electronic Systems.

Robert L. Gutreuter: Promoted manager of the logistic services department at Motorola's Chicago Military Electronics Center. He replaces **William Griffiths,** who has been promoted to director of subcontract sales.

Dr. Dan D. Epps: Joined Electro-Tec Corp. as head of the electro-optical department. Before joining Electro-Tec he was a designer, special consultant on optical problems and engineering manager of special projects at the Aero Div. of Honeywell, Inc.

Maj. John M. Bialo: To serve as the U.S. Army Test and Evaluation Command's top technical advisor on electronics. He is now with the office of the Army chief of Research and Development as a mobilization designee.

Edwin E. Clarke, Jr.: Appointed manager of manufacturing at Pall Trinity Micro Corp. **Henry D'Amato** recently resigned from the position.

Dr. John Gagliani: Joined the research department of the G. T. Schjeldahl Co. He will become senior research scientist.

Leslie D. Jacobs: Appointed vice president of military and space relations of the Electronic Instrumentation Div. of Lear Siegler, Inc. He will be responsible for all phases of marketing of the electronic instrumentation division's ground support and instrumentation systems.

Dr. Gale W. Cleven: Elected to the board of directors and appointed executive vice president of Networks Electronic Corp. Until recently he has been serving as director of data processing for Hughes Aircraft Co.

Dr. Edward A. Miller: Named general manager of the *MOL* department of General Electric Co.'s Missile and Space Div. for work on the Air Force's *Manned Orbiting Laboratory* program.

Col. Paul G. Galentine, Jr.: Assigned deputy for engineering and technology at the Electronic Systems Div. of the Air Force Systems Command. He will be responsible for providing engineering and technical support to system program offices and to the deputy for advanced planning.

Col. Elwood Douthett: Appointed director of the Air Force Propulsion Lab. He is an electrochemical and nuclear power research and development specialist.

Stanton H. Wong: Joined Planning Research Corp. as a senior associate in its computer applications department. He will assist in the design of software for a title insurance automation project at the firm's Los Angeles headquarters office.

T. C. Burnette, Jr.: Named chief mechanical engineer for C. P. Clare & Co.'s Fairview, N.C., plant. He will be responsible for relay design and development work at this location.

D. F. Quigley: Joined the Bunker-Ramo Corp. as a member of the technical staff in the Washington, D.C., office of the company's Defense Systems Div. He was formerly a Navy captain.

James B. Treacy: Appointed executive director, foreign aerospace and industrial affiliates for international operations of the Bendix Corp. He currently serves as a member of the board of directors of several European and Canadian affiliates of the Bendix Corp.

George H. Kunstadt: Appointed director of engineering for the Components Div. of Librascope Group, General Precision, Inc. He will be responsible for all engineering activities in connection with the division's line of disc memories, encoders, integrators, and other computer components.

when and where

Liquid Propellant Combustion Instability Working Group, sponsored by the Interagency Chemical Rocket Propulsion Group, Aerospace Corp., Los Angeles, Calif., Nov. 1-5.

1965 International Space Electronics Symposium, sponsored by the Institute of Electrical and Electronics Engineers, Fontainebleau Hotel, Miami Beach, Fla., Nov. 2-4.

Seminar on "Determination of Physical Properties of Materials Through Sonic Resonant Methods," sponsored by Magnaflux Corp., Battelle Memorial Institute, Columbus Laboratories, Columbus, Ohio, Nov. 3-4.

National Security Industrial Assn. Research & Development Symposium, Department of State main auditorium, Washington, D.C., Nov. 3-4.

Northeast Electronics Research and Engineering Meeting, sponsored jointly by New England Sections of the Institute of Electrical and Electronic Engineers, Sheraton-Boston Hotel, Boston, Nov. 3-5.

Society of Engineering Science technical meeting, sponsored by the Society of Engineering Science, University of California at Davis, Davis, Nov. 3-5.

Society of Plastics Engineers Regional Technical Conference, sponsored by the Society of Plastics Engineers Western New England Section, Statler-Hilton, Hartford, Conn., Nov. 4.

77th Annual Meeting of the Geological Society of America, sponsored by the Geological Society of America and related societies, Muehlebach Hotel, Kansas City, Mo., Nov. 4-6.

1965 Space Fair, sponsored by the Navy, Pacific Missile Range Headquarters, Point Mugu, Calif., Nov. 6-7.

1965 Winter Annual Meeting of the American Society of Mechanical Engineers, Chicago, Nov. 7-12.

American Society for Quality Control 1965 Aircraft & Missile Division Conference, sponsored by Cape Canaveral Section, A.S.Q.C., Ramada Inn, Cocoa Beach, Fla., Nov. 8-10.

Seminar on "Effect of Temperature on Metals," sponsored by the American Society of Mechanical Engineers, Chicago, Nov. 10.

18th Annual Conference on Engineering in Medicine & Biology, sponsored by the Institute of Electrical & Electronics Engineers, Instrument Society of America, Sheraton Hotel and University of Pennsylvania, Philadelphia, Nov. 10-11.

Nuclear Spin-Parity Conference, co-sponsored by the Oak Ridge National Laboratory and American Physical Society, Gatlinburg, Tenn., Nov. 11-13.

Fall National Meeting of the Society of Aerospace Material & Process Engineers, sponsored by the Society of Aerospace Material and Process Engineers, Biltmore Hotel, Dayton, Ohio, Nov. 15-17.

1965 Atomic Fair and Winter Meeting of the American Nuclear Society, sponsored by the American Nuclear Society, Sheraton Park Hotel, Washington, D.C., Nov. 15-18.

International Congress on Air Technology, sponsored by the Valley Education and Research Foundation and the Arkansas Industrial Development Commission, Hot Springs National Park, Ark., Nov. 15-18.

Fourth Annual Symposium on the Physics of Failure in Electronics, co-sponsored by Rome Air Development Center, Griffiss Air Force Base, and IIT Research Institute, Grover M. Hermann Hall on the campus of Illinois Institute of Technology, Chicago, Nov. 16-18.

National Conference for Space Age Facilities, sponsored by the Florida chapters of the Society of Civil Engineers, Aero-Space Transport Div., Society of American Military Engineers, Canaveral Council of Technical Societies, and the Florida Engineering Society, Ramada Inn, Cocoa Beach, Fla., Nov. 17-19.

International Conference on Tropical Oceanography, sponsored by the Institute of Marine Science, Institute of Marine Science, Miami, Nov. 17-24.

1965 Fall Computer Conference, Convention Center, Las Vegas, Nev., Nov. 30-Dec. 2.

Vehicular Communications Conference, sponsored by the Institute of Electrical & Electronics Engineers, Sheraton-Park Hotel, Washington, D.C., Dec. 2-3.

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To the Moon, Softly

THE DIFFICULTIES of soft-landing a payload on the Moon are substantial. The successive Russian failures to do so are sufficient evidence of that fact.

But even as the Soviets shatter vehicles on the lunar surface, the equivalent American program, *Surveyor*, is having problems getting off the ground. Rep. Joseph E. Karth (D-Minn.) has now delivered the *Surveyor* report of his NASA Oversight subcommittee to the House Space Committee.

It is a document which pulls no punches and is in line with the tradition of objective, useful investigation established by Mr. Karth, and indeed the entire committee.

That there have been technical difficulties and mismanagement in the project cannot be questioned. It is true that *Surveyor* has slipped at least two and one-half years and equally true that costs have skyrocketed to some $350 million thus far—indicating a probable total of $725 million for 10 flights.

Nevertheless, the report's emphasis on this seems to us a little harsh. The real blame for *Surveyor's* troubles lies in the basic assumption that any organization, starting in 1961, could soft-land the first of seven spacecraft on the Moon in two years—and all of them at a cost of some $50 million.

Even taking cognizance of how little knowledge of spaceflight existed in 1961, the timetable and cost estimates are so incredibly naive as to be beyond belief. Surely, as much blame must rest on Congress for buying such a program as on the National Aeronautics and Space Administration and Hughes Aircraft for failing to carry it out.

Considering this inherent defect, the really amazing thing is that what the Karth report calls the "stormy 4½-year history" of the project has not been stormier. Given a limited budget to accomplish the impossible, anyone will have difficulties.

In fairness, it should be said that the House and Senate space committees themselves are today considerably more sophisticated than they were when Project *Surveyor* was initiated. It is unlikely they now would agree to any program as ill-defined as this one was in the beginning.

The Karth report, in fact, acknowledges this when it states: "In essence, insufficient preliminary work was done prior to the decision to go ahead with the project, and the award of a contract for development of the *Surveyor* spacecraft."

The subcommittee has found the heart of the problem but has not been entirely charitable in judging subsequent events in light of the fact.

Let's take a look at some of the things *Surveyor* must do—and that Jet Propulsion Laboratory and Hughes Aircraft must make it do. First, relying upon a *Centaur* booster which even now is relatively unproven, it must successfully accomplish all the guidance and mid-course maneuvers of its *Ranger* predecessor. Then, it must change its attitude to align the retro-engine for a backward descent to the lunar surface. The engine must slow the spacecraft from 9,000 to 350 feet per second. During this entire period, the vernier propulsion system must maintain a constant spacecraft attitude. Spacecraft descent is automatically referenced to the lunar surface by a precision radar altimeter and a three-beam Doppler velocity sensor. The spacecraft must free-fall to the surface from an altitude of 13 feet, depending upon landing-gear shock absorbers, crushable footpads and crushable blocks on the bottom of the spaceframe to cushion the shock and to keep it in an upright position on its tripod gear.

Surveyor must then align its solar panels and planar array antenna before carrying out a number of experiments, all the while surviving the hot and cold extremes of the lunar day and night. Data from those experiments, limited to a single TV camera on the first four missions, must be relayed to Earth.

How anyone could have expected to accomplish this within the framework of the project as originally outlined is just not comprehensible. If it can be done within the present schedule and cost estimates, Hughes and JPL will have achieved something remarkable.

None of this, however, should be allowed to obscure the Karth subcommittee's very valid criticisms of the project. Some of the management decisions were, to say the least, questionable.

The vagaries of the vernier engine subcontract are a case in point. As the subcommittee reports, Hughes notified JPL in February, 1964, that the vernier thrust chamber assembly subsystem had encountered severe technical difficulties. Hughes recommended that Rocketdyne be brought into the program as a backup to the initial subcontractor, Reaction Motors Div. of Thiokol Chemical. Instead, JPL the following month directed Hughes to cancel the RMD contract. JPL contracted with TRW/Space Technology Laboratories for the vernier engines.

STL ran into difficulties. Reaction Motors, meanwhile, undertook a redesign of the subsystem which successfully solved some of the technical problems. JPL thereupon canceled the STL contract and reinstated the contract directly with RMD. All of this took place within four months.

ONE MUST AGREE with the report when it states: "A project as troublesome as *Surveyor* demands vigorous centralized management and effective control at the top. From all appearances, these important elements have been largely missing right from the beginning of the project."

It is not trite to say that a lesson has been learned. And it can be truly added that if the U.S. successfully soft-lands a *Surveyor* on the Moon next year, the cost and time expended will not have been unreasonable.

Just how much it will contribute to Project *Apollo* is, of course, another question—and one the Karth subcommittee did not take up.

William J. Coughlin

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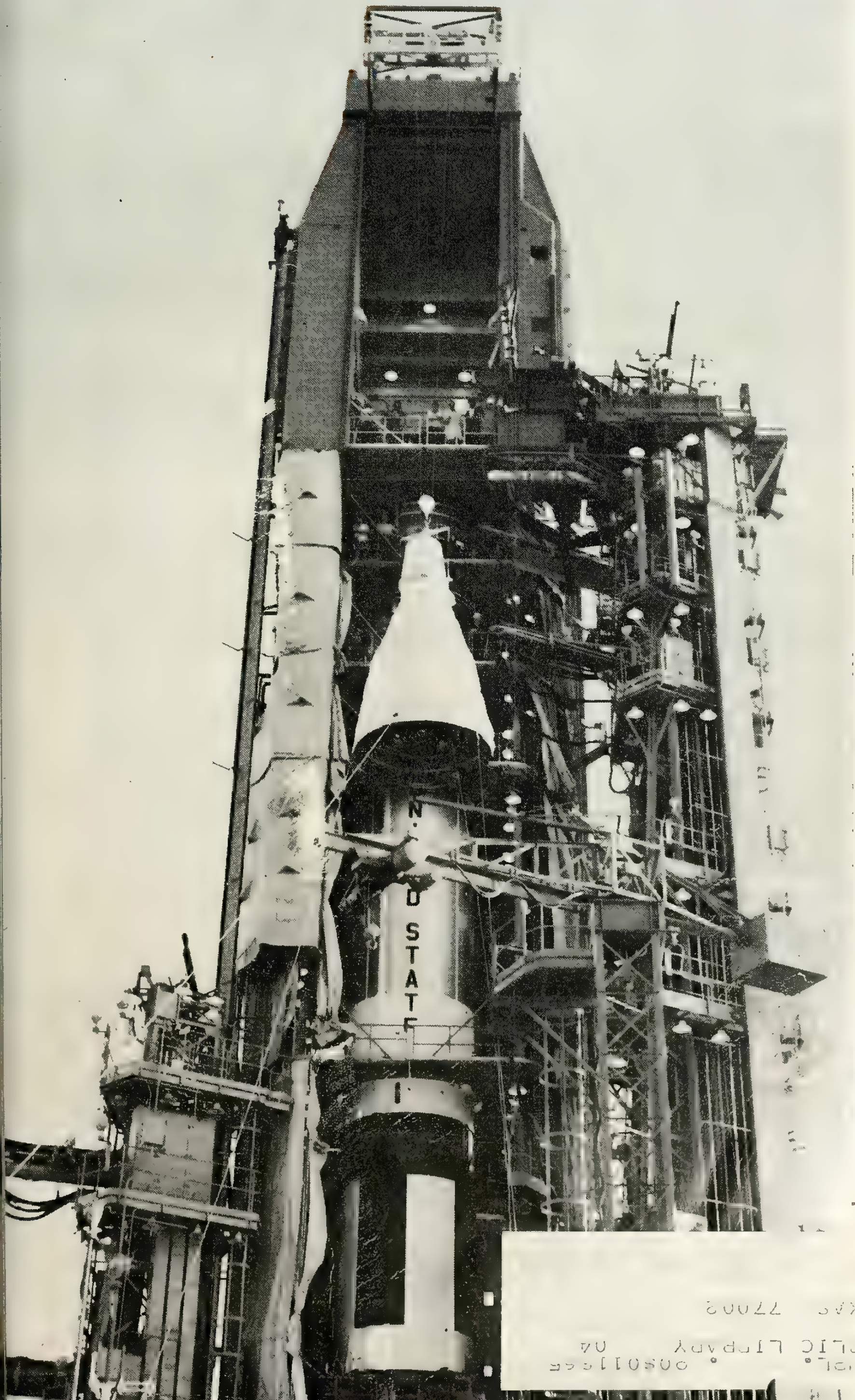

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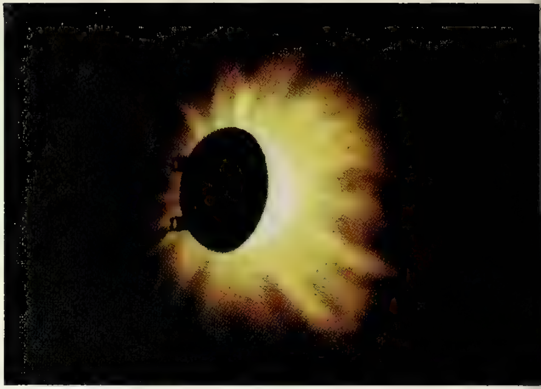
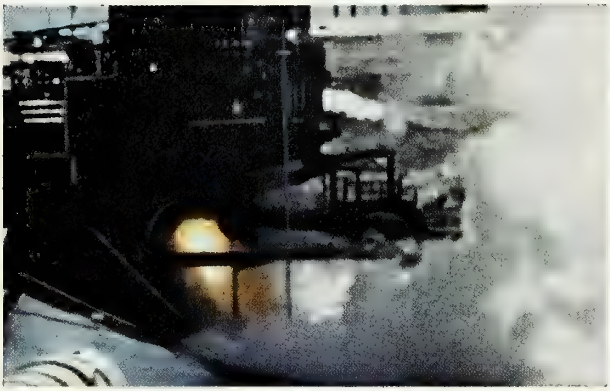
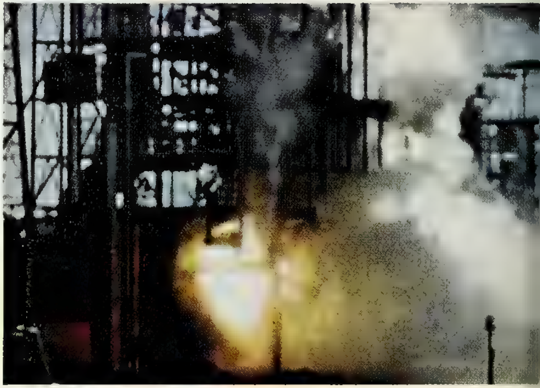


JULY 1959: First RL10 fired.

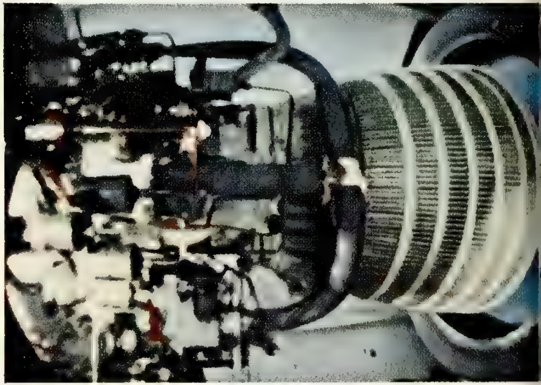


MARCH 1962: Static firing of first Centaur test vehicle, powered by two RL10s.

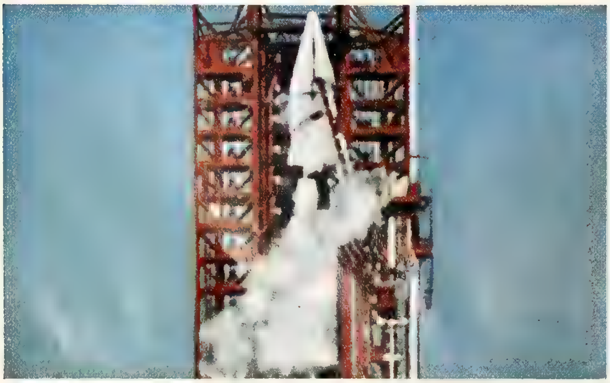


AUGUST 1962: Static firing of Saturn S-IV stage, powered by six RL10s.

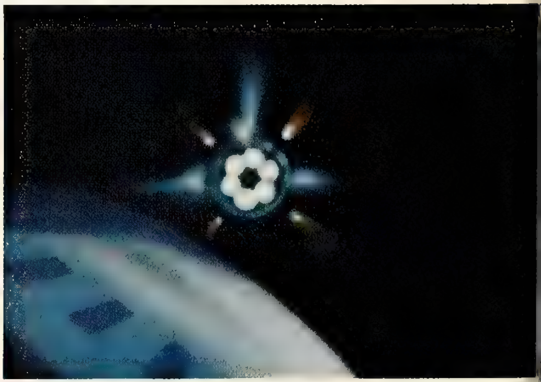
SEPTEMBER 1962: RL10 throttleability demonstrated.



JUNE 1963: RL10 instant stop-start capability demonstrated.



NOVEMBER 1963: RL10s power first Centaur vehicle in orbit.



JANUARY 1964: RL10s power first Saturn S-IV vehicle in orbit.

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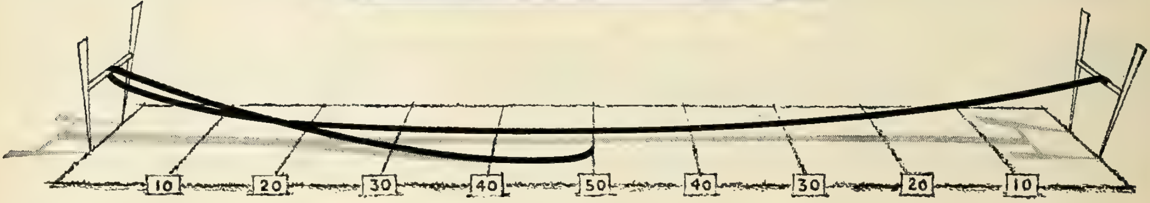

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THE COVER

Gemini 7 spacecraft is positioned above its assembled Titan II launch vehicle on Launch Complex 19 at Cape Kennedy. NASA is seeking to put the spacecraft into orbit on Dec. 8, then follow it with Gemini 6 in 9-12 days—hoping to achieve a rendezvous within a few feet. See story on p. 14.

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letters

Complacency

To the Editor:

Russia has profited in the world market with the technological image they created by investing in space achievements. They do not intend to destroy this image by not contending in the Moon Race. But instead of using just Earth-orbit-rendezvous, as mentioned in your Oct. 18 editorial ("Hardly a Time for Complacency"), they will probably use a combination EOR/Lunar-orbit-rendezvous to minimize the number of launches and to save the cost of developing a booster as large as *Saturn V*. It will be cheaper initially and less efficient per mission than *Apollo,* but all they want is that historic first.

There are many shortcuts Russia can take. They have skipped the two-man capsule. *Proton 1* probably used a thrust-augmented *Voskhod* booster, so they can still develop a single super booster, unlike the U.S. which is working on four (*Saturns I, IB* and *V* and *Titan III-C*). They can use uprated operational engines and existing tooling to cluster engines and tanking on a common framework, as we did with *Saturn I.* Instead of eight, they may use 11, with seven in the center and four gimbaled outriggers for steering. And they can build, test and fire at the launch site instead of shipping stages around by barge.

The *Polyots,* not mentioned Oct. 18, can be used for unmanned EOR to leisurely establish an orbiting propellant dump before cosmonauts are sent up to reassemble these fueled sections into Moon-bound challengers of *Apollo.*

John B. Stevenson
Cape Canaveral, Fla.

Information Straw Man?

To the Editor:

I strongly suspect that the "information problem" that is getting so much attention even in your magazine, particularly last week's issue, is mostly a figment of computer engineers' and librarians' imaginations.

With science and technology broken down into such highly specialized compartments these days, a specialist would really have to try hard *not* to know what is going on in his field. And he'll know that his work is at least 50% duplicative of his competitor's.

The problem arises when people want to expand their fields of interest, but this is a learning problem more than one of a surfeit of information—just as a man who wants to learn tensor analysis is chagrined not that there is too much information about the subject but that the subject involves a new vocabulary and is difficult to master.

The most economical way to solve this problem is to consult with the specialist in the new field or hire him.

What we need is a winnowing machine to get rid of all duplicative reports and ego-boosting articles. With these gone, an expert's reading could probably be reduced to an hour or so a day—if he's a slow reader.

William Hyman
Brooklyn, N.Y.

None So Blind . . .

To the Editor:

This morning on the radio I heard a news commentator (who shall be nameless) on a network (which I shall not identify) say that what occurs in the next, post-election, four years in New York City will determine what happens to *all* urban areas in the U.S. from now on. He went on to say that events may persuade the U.S. Government to invest in supporting NYC the funds it had intended to devote to Moon exploration.

I mention this because it is the first time I have heard narrow provincialism combined with cosmic shortsightedness.

David J. Barker
Philadelphia

The Ugly American

To the Editor:

Your Oct. 4 editorial might jar Greek pride somewhat—Thessalonica was named after the wife of Cassander (one of the Diadochi—Successors—of Alexander) about eight years after Alexander's death; it was formerly a small village called Therma, Athens owning it before Cassander included it in Macedonia. The Macedonian capital was Pella, about 30 miles away, inland in the mountains, at that time.

After this carping, I must add that I agree that it is highly regrettable that the U.S.A. should allow itself to be outdone by the U.S.S.R. in courtesy and cooperation, with news services to the detriment of its international image.

Paul L. Sowerby
Manchester, England

Our reference was intended to be to the area, rather than to a specific city. But we are glad to have this learned amplification.—Ed.

REPRINTS

A 36-page reprint of the MISSILES AND ROCKETS *special report on oceanology, which appeared in the Sept. 6 issue, may be obtained from:*

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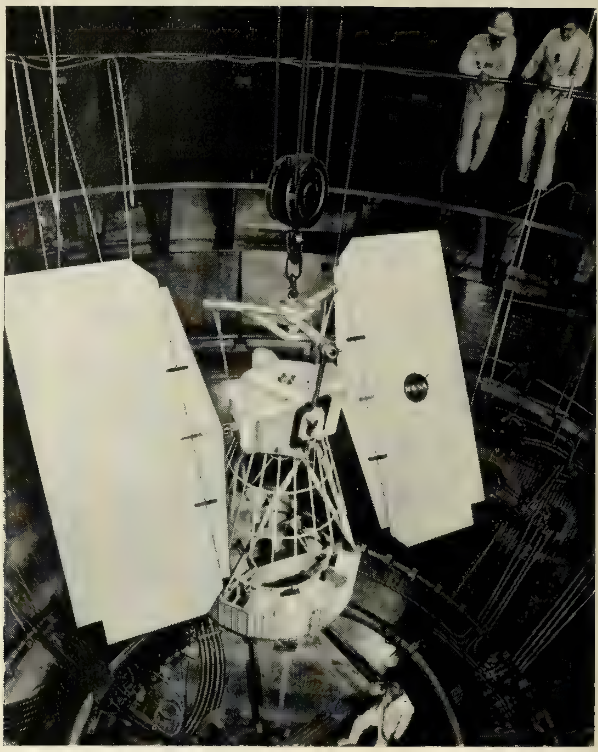

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The Countdown

WASHINGTON

HIBEX Passes Stiff Test

ARPA sources say pre-planned flight maneuvers during the Oct. 28 launch of *HIBEX* (high-acceleration experimental missile booster) were more challenging than any attempted in earlier tests. This was the first launch of the 17-ft. missile from its underground test cell. Test was designed to study the effects of silo launch.

Minuteman Cable Link-up Completed

First linkage of a *Minuteman II* underground command post with its 10 missile silos by buried, blast-resistant communications cable has been completed at the *Minuteman* Wing IV complex at Grand Forks, N.D. Eventually, all 150 missile silos and 15 command posts, dispersed through a 7,500-sq.-mi. area, will be linked by the cable. Sylvania Electronic Systems is in charge of the project. Back-up radio communications link uses buried underground antennas.

No Funds for M-1 Engine

There will be no funds for the M-1 liquid hydrogen engine in the NASA budget for the new fiscal year. The space agency will ask for funds for two other projects killed by the Johnson Administration before submission of this year's budget but revived by Congress. A small amount will be asked to keep the *SNAP 8* project going and approval will be requested for Phase II of the 260-in. solid motor demonstration program.

New Role Proposed for Big Solids

Some advocates of big solid engines are pushing a new use with the Air Force. They propose replacing *Titan III-C* solid strap-ons with a single large solid of 260-in. or larger to boost the core. Weight and cost savings are claimed.

MOL Information Policy Unclarified

Industry concern over possible closed-door information policy on the *Manned Orbiting Laboratory* project was not allayed last week in Los Angeles by Air Force Secretary Harold Brown. Said he: "I can assure you it is going to be handled on the basis of military security as all military matters are." Which left things just where they were. Real bind is this: how can the Administration admit development of a manned reconnaissance system when it refuses to acknowledge existence of the *SAMOS* unmanned reconnaissance system?

High-Energy Stage RFP Upcoming

Request for proposals will be issued before the end of the year by Lewis Research Center for studies of systems for NASA's planned high-energy kick stage to be used as the final booster for interplanetary missions. FY '66 funds will be used. Stage will employ liquid fluorine. Reports of the thrust requirement vary from 7,000 lbs. to 15,000 lbs. Operational date is 1972.

The Burning Problem of Weight

Weight problems on the *Manned Orbiting Laboratory* already are causing the Air Force concern. One solution under study is an extension of the burn duration of the *Titan* core vehicle. Air Force Rocket Propulsion Laboratory is said to be considering funding a program to increase burn duration. This could involve modification in the gearbox between the turbine and the pump. Fix might involve a larger heat sink in the gearbox casing or an artificial means of cooling.

No Room for Extrapolation

What appears to be a recent leveling off in overall Federal funds for research and development should not be taken as a permanent trend, according to Presidential Science Adviser Donald F. Hornig. He says it is the result of an accidental combination of circumstances rather than a reflection of any underlying policy. New programs will continue to be funded on worth, with no hard rule on level of effort, according to Hornig.

Change in Biosatellite Schedule

NASA is switching its schedule in the *Biosatellite* program. Under the new plan, the first launch will be a three-day mission to be followed by 30-day and 21-day missions.

INDUSTRY

NAA Gets Apollo Applications Funds

North American Aviation has received $996,000 in additional funding from Manned Spacecraft Center to investigate the capabilities of the *Apollo* spacecraft for *Apollo* Application synchronous, polar and lunar orbit missions. This brings total value of that contract to $3,456,000. Results are due at MSC in January.

Space-General Gets Capsule Study

Space-General Corp. has been asked by Manned Spacecraft Center to submit technique and cost proposals for design of two "survivable" capsules of specified scientific payload for the lunar survey probe. Company holds a study contract for $238,616 for design of the probe delivery system. Philco Corp. holds a similar study contract. Capsule is to be impacted on the lunar surface from an *Apollo* spacecraft. Hughes Aircraft holds a smaller contract for study of a modified *Surveyor* as a lunar landing probe from *Apollo*.

INTERNATIONAL

AS-37 Missile Gets Name

AS-37 air-to-ground missile under joint development in France and the United Kingdom has been given a name—*MARTEL*. The acronym is for Missile Anti-Radar Television.

Australians Worry over Tartar Cost

The Opposition has raised the question in the Australian Parliament of the cost of *Tartar* missile systems to be installed aboard three Charles F. Adams-class destroyers being built in the U.S. for the Australian navy. Cost of the system was put at $27.3 million for each ship, twice the cost of the destroyer itself. The Opposition leader raised the question of whether, in view of Australia's experience with the Ferranti Company over the *Bloodhound* missile, it was being similarly overcharged for the *Tartar* missile. It was later stated by government sources that Australia was buying the missile from the U.S. Navy and not directly from the manufacturer.

Firms Win SRAM Awards

Boeing Co. and Martin Marietta Corp. have won Phase 1B contract definition awards from the Air Force for the *SRAM (Short Range Attack Missile)*.

Both firms will be awarded fixed price contracts valued at about $2.75 million each. The competing contractors will submit further proposals if a decision is made to go forward with *SRAM* into the production phase. In that case, a single contractor will be selected in late summer of 1966 (M/R, Oct. 11, p. 9).

In the definition phase, the Air Force will attempt to verify the preliminary design and engineering and to set firm contract and management planning. *SRAM*, which is designed to be carried by both the F-111 and late models of the B-52, has a nuclear capability and is judged by high Pentagon officials to be an important prospective part of the future strategic posture of U.S. forces.

Apollo Crawler Fixed

Installation of the sleeve bearings to replace faulty roller bearings in the crawler-transporter for the *Saturn V-Apollo* combination will be completed by December 1, the space agency says.

Other more minor problems in the steering system and automatic leveling system also appear to be near solution. The hydraulic valves in the steering system have been replaced and the operating pressure raised from 3,600 to 4,800 psi, allowing the necessary increase in steering torque to overcome the higher-than-anticipated ground friction. In the leveling system, the manual leveling mode will be used until the electrical fixes are made.

Incentive Contracts Criticized

There is a "grave question about the effectiveness of incentive contracts for R&D work," Edward B. Roberts, Associate Professor of Management at Massachusetts Institute of Technology, told 500 of the nation's leading industrialists.

Not only do incentive-type contracts not contribute benefits but "they bring up significant new problems," Roberts said at a Research and Development symposium sponsored by the National Security Industrial Association, Nov. 3-4 in Wash., D.C. These contracts include the following drawbacks: 1) a delay in the contracting process itself, usually amounting to six to eight months; 2) wasting the time of scientists and engineers on drawn-out contract negotiations, and 3) worsening industry-Government relationships as a result of contract bickering.

Seeing strong advantages to sole-source procurement, oral R&D proposals, informal proposals, and other non-incentive means for buying R&D work, Roberts noted that incentive contracting adds about one-quarter to one-half of a time period to the life cycle of the average R&D contract. This finding is based on an MIT study of a number of R&D Government contracts ranging in cost from a few hundred thousand dollars to about two million dollars, with contract lifetimes from six months to two years.

Roberts criticized both industry and Government for 1) not learning how to manage R&D more effectively, and 2) not utilizing R&D results to better advantage. Documenting his first point, Roberts told of another MIT study in which it was found that companies holding cost-plus-incentive-fee and fixed-price-plus-incentive-fee contracts treat them as they do cost-plus-fixed-fee contracts. Roberts attributed this to many managers still thinking in terms of production and not in terms of R&D, thereby losing advantages they might otherwise have gained.

Shots of the Week

The Soviet Union orbited a second *Proton* scientific satellite Nov. 2 in what some observers believe may be a prelude to the orbiting of a space station to be followed by a crew-carrying orbital transporter. Weight of *Proton 2* was given as 24,400 lbs., the same as *Proton 1* launched July 16. Apogee was reported as 395.7 mi.; perigee, 118.6 mi.; period 92.6 minutes; and inclination, 63.5 degrees. The satellite carries equipment to study cosmic particles and solar cosmic rays.

- The Army's *High Acceleration Experimental Missile Booster (HIBEX)* underwent its first test firing from an underground silo at White Sands Missile Range, N.M., Oct. 27.
- The Soviet Union on Oct. 28 orbited *Cosmos 94*.
- Air Force Major Robert Rushworth flew the Air Force-NASA *X-15* rocket plane Nov. 3 in the first test of two external fuel tanks designed to enable increased speeds up to 5,000 mph.

'Penkovsky Papers' Disputed

Comparing U.S. and Soviet space programs before an American Institute of Aeronautics and Astronautics audience in Washington Nov. 4, Dr. Charles S. Sheldon II reported: "To our knowledge, neither country has lost an astronaut or cosmonaut in space flight." Dr. Sheldon is a member of the National Aeronautics and Space Council.

His public comment coincides with remarks made to MISSILES AND ROCKETS in private by respected spaceflight analysts, who have contradicted serialized newspaper accounts said to be the memoirs of ex-Soviet spy Col. Oleg V. Penkovsky.

The "Penkovsky Papers" are said to have been smuggled out of the Soviet Union in 1962 at about the time Penkovsky was arrested. Included are statements that before the successful flight of Cosmonaut Yuri Gagarin, several Soviets were killed in unsuccessful efforts.

Titan III-C Probe Results

Preliminary Air Force investigation of the upper stage failure experienced in orbit during the Oct. 15 *Titan III-C* launching indicates leakage problems in both the second and third (Transtage) stages of the vehicle and faulty valve operation in the Transtage.

The latter malady may have caused the actual tumbling and breakup of the Transtage in orbit and the resultant loss of the two small satellites it carried (M/R, Oct. 25, p. 10).

Air Force officers at Space Systems Div. say they are now making more detailed studies to determine whether any changes will be made in the vehicle prior to the next flight, slated for the first week in December. Decision on the need for any change was expected late last week. Payload for that flight, which will also be the first to fully exercise the ITL launch concept for *Titan III*, will include the *OV2-3* satellite and a Lincoln Laboratory experimental package.

Telemetry on the last flight showed a slight oxidizer leak in the second stage, probably in the vent and pressurization line, which oc-

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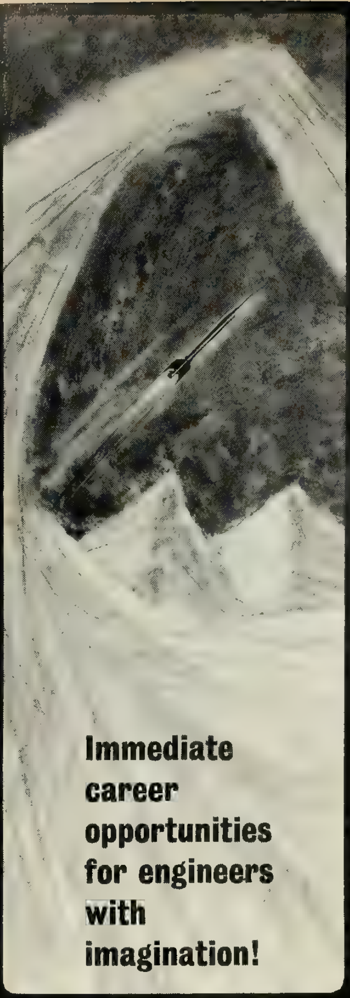
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curred during operation of the first stage. A Transtage fuel leak was also indicated during coast, according to the Air Force, by a decay in the fuel tank pressurization and steady torque in the vehicle. Telemetry indicates that this leak may have started during operation of the second stage.

While first and second stage operation was normal, analysis shows that after separation of the second stage and Transtage, during the brief period when the second stage retro rockets were backing it off, combustion apparently occurred due to either the Transtage fuel mixing with second stage oxidizer, or the fuel-rich Transtage attitude control engines exhausting into the leaking second stage oxidizer.

Engineers theorize that the resultant "mild shock" imparted to the Transtage increased the separation velocity and could have aggravated the fuel leak. However, Transtage first burn was normal.

The serious trouble in Transtage began during the second burn when one of its two thrust chambers shut down normally, its bipropellant valve operating properly, while the other chamber valve moved only a small portion of full travel. With one chamber still delivering most of its 8,000 lbs. thrust, the Transtage and payload began to tumble and eventually broke up.

Electronics Forecast Is Rosy

First five-year sales forecast for the electronics industry to be published by the Electronic Industries Assn. predicts the Government market will expand 36% by 1970 to reach $12.48 billion. This expansion is attributed to increasing electronics penetration into equipment and systems purchased by federal agencies.

Presented by Dr. Harper Q. North, vice president, Research and Development, TRW, Inc., and president of EIA, Nov. 2 at the EIA Winter Conference in Los Angeles, the report forecasts that the total electronics marketing business is likely to grow from a current $17 billion to $23.9 billion by 1970.

In 1970, the Government market is expected to account for 52.3% of the total electronics business.

Defense Dept. expenditures, while growing in dollar volume, are expected to become a decreasing percentage of the total Government budget.

The EIA view is that military expenditure will reach $55 billion in the FY 1970 budget. Inadequacies in present communication equipment, particularly at the tactical level, together with increasing sophistication, leads EIA to predict that DOD will purchase $10 billion in electronic goods and services by 1970. The estimate is a conservative one and would increase rapidly if the international environment changed sharply for the worse.

NASA expenditures are expected to grow slightly above the present levels, exceeding the Fiscal Year 1966 budget by only $400 million by 1970. This rather slow expansion in comparison with previous predictions is based on EIA's view that there will be greater demands for military hardware, and that NASA has "failed so far to develop post-*Apollo* programs that are both glamorous and scientifically viable."

FCC Nears Comsat Decision

The Federal Communications Commission has begun evaluation of comments from 27 interested parties on the question of who should be authorized to buy service from the Communications Satellite Corp.

Basic question is whether U.S. common carriers should be Comsat's sole customers, or if newspapers, wire services and other such entities should be allowed to lease satellite circuits directly from the corporation. The number of respondents to the FCC's request for comments last June indicates a strong interest in future international communications via satellite. Several of the entities submitting comments have also indicated an interest in putting up communications satellites of their own. Comsat has opposed this as contrary to the intent of the Communications Satellite Act of 1963.

Replies to the original comments are due Dec. 1. Indications are that the FCC may make a decision by mid-February.

OGO II Partially Revived

NASA's Goddard Space Flight Center reports that it has initiated action that will permit the *Orbiting Geophysical Observatory II* to transmit data one day out of every three.

The center said that by taking advantage of the spacecraft's motion and the Sun angles of its solar cell panels, the paddles can still be lined up with the Sun and power built up.

The improvisation was initiated on Oct. 29, when 20 hours of data was received from 19 of 20 experiments on board the spacecraft. The value of the data will not be known until it can be evaluated.

New Russian Missile Tests

The Soviet news agency, Tass, has announced that a series of Soviet rocket tests, including launch of "a new modified space vehicle booster," will take place between October 31 and December 30. The rockets will be fired into an 80-mi.-diameter circular target area in the Western Pacific, centered upon 19 degrees 8 minutes north and 178 degrees 46 minutes west.

Comsat Gets Apollo Go-Ahead

The International Telecommunications Satellite Consortium has approved plans of the Communications Satellite Corp. to provide communications services for use with the *Apollo* program.

The group gave Comsat a go-ahead to award an $11.7-million contract to Hughes Aircraft Co. for construction of four synchronous satellites (M/R, Oct. 25, p. 12). Approval by the Federal Communications Commission was expected late last week.

NASA Buying 12 Scouts

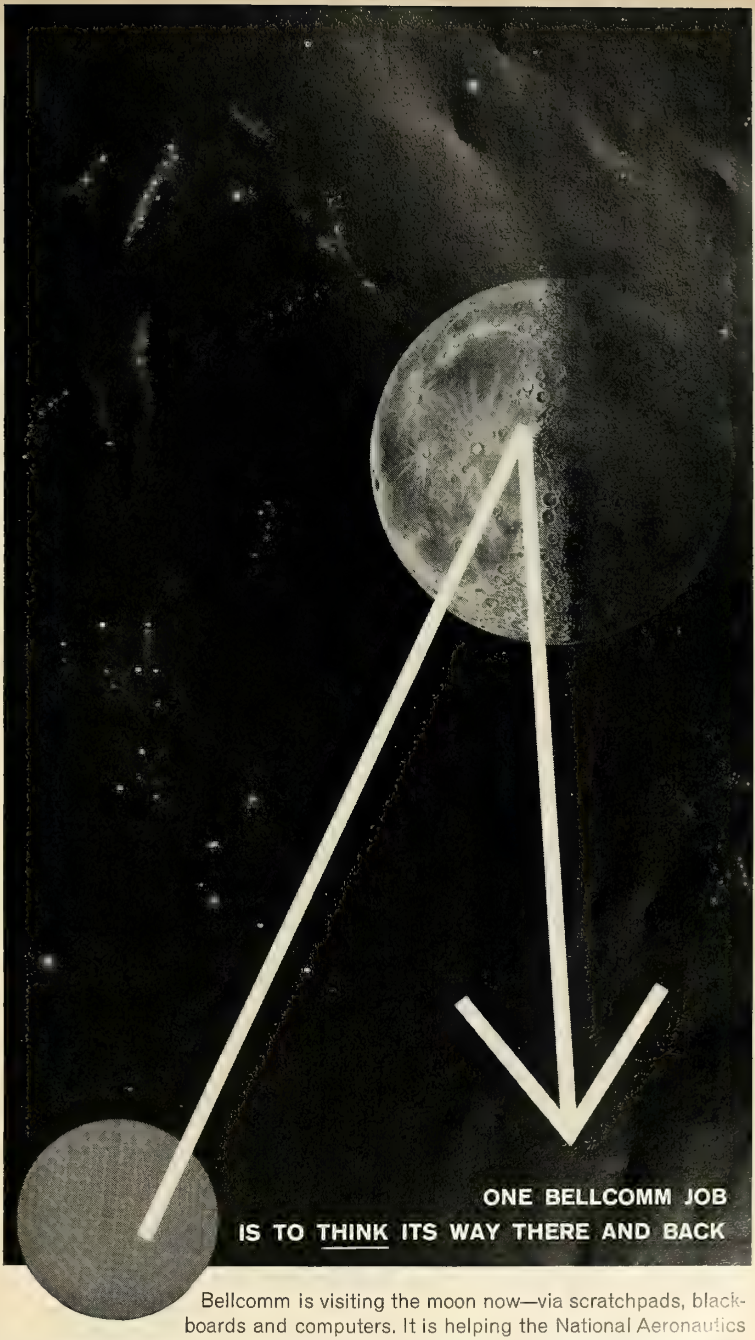
NASA is negotiating with Ling-Temco-Vought, Inc., for purchase of 12 *Scout* launch vehicles.

Major subcontractors for the $8-million award include Aerojet-General Corp., for the first-stage rocket; Thiokol Chemical Corp., second stage; Hercules Powder Co., third stage, and United Technology Center, fourth stage.

Walter Kidde & Co. is expected to provide various reaction control and hydrogen peroxide systems; Minneapolis-Honeywell Regulator Co. will furnish guidance system packages.

Dandridge Cole Dead

Dandridge M. Cole, a consulting astronautical engineer with the Space Vehicle Department of General Electric's Missile and Space Div. and one-time contributor to MISSILES AND ROCKETS, suffered a fatal heart attack at work on Oct. 29. Cole was an armament analysis staff engineer with the Martin Co. and a science instructor at the Academy of New Church, University of Pennsylvania, and Phillips Exeter Academy, before joining GE in 1960.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Dual Gemini Flight May Start Dec. 8

Gemini 7 launch would be followed by Gemini 6 in 9-12 days in attempt at close rendezvous; Agena failure review critical

by Jinx Mercer

HOUSTON—Astronauts Frank Borman and James A. Lovell may shed their lightweight emergency suits in orbit to become the first U.S. astronaut team to fly in shirtsleeves.

Plans for the two-week *Gemini 7* flight and the attempt to rendezvous the *Gemini 6* spacecraft with it were revealed at a press conference at the Manned Spacecraft Center.

The dual mission is expected to be scheduled for as early as Dec. 8, but slippage into January is possible.

"We hope to fly in a shirtsleeve environment for up to 10 days," Borman elaborated. During this exercise, the suits will be rolled up inside the flexible visors and strapped to the seats. The crew will be wearing only underwear, but a second set of thermal "long johns" will be available for warmth.

McDonnell Aircraft Corp. in recent weeks performed a failure analysis of the *Gemini* cabin pressurization system, Borman said. "There are no major points of catastrophic failure." Only a rapid decompression of the cabin would leave them with too little time to don the suits. (In practice runs, it took Lovell 12 minutes to don the suit in the spacecraft.) Borman added: "We would be too late even with only helmets off in the event of a rapid decompression."

- **Recouping GTA-6 losses**—Space agency officials earlier had reported that the attempt to rendezvous the *Gemini 6* spacecraft with *Gemini 7* was approved to salvage some of the desired data and experience in rendezvous and docking lost Oct. 25 when the *Gemini 6* target vehicle failed to go into orbit.

The plan is based on a Martin Co. study that found the rendezvous of the two *Gemini* spacecraft is feasible.

The *Gemini 7* will be launched first. Nine to 12 days later, the *Gemini 6* spacecraft will be erected and launched in an attempt to come as close as a few feet from its orbiting twin.

The rendezvous attempt hinges on NASA's ability to get the *Titan II* booster pad cleaned up and the *Gemini 6* launch vehicle erected and checked out in the almost impossible period of little more than a week, but space agency officials said they believe they have a good chance for success.

NASA still maintains that the first U.S. docking mission in space will not be attempted until the second quarter of 1966, although official planning schedules previously had it earmarked for February.

- **Agena post-mortem**—The actual flight date hinges on a review of the *Agena* failure, cause of which still had not been pinpointed late last week.

It was disclosed that data indicated ignition of the primary booster system was achieved, but that all tracking of the target vehicle was lost shortly thereafter.

The most likely cause, NASA officials said, was a valve malfunction that caused an explosion.

The *Gemini 7* team will attempt to stay with the second stage of the *Titan II* booster for a short period after orbital insertion. The station-keeping maneuver, originally planned to last a full orbit, has been cut short to conserve fuel. Prior to the *Gemini 6* launch, the *Gemini 7* spacecraft will be required to circularize its orbit at 161 n. mi., Borman explained.

The maneuver, which requires approximately 100 lbs. of fuel, will not be performed "until there's a fair degree of certainty that *Gemini 6* is actually going to get off the ground," Borman said. About 40 lbs. of the fuel will come from the experiment allotment and the rest from the "orbit trimming" reserve, he added.

Astronauts Walter M. Schirra and Thomas P. Stafford may be launched in *Gemini 6* no earlier than the eighth day of the *GT-7* flight. Launch windows on this and subsequent days alternate between one and two 25-min. windows daily. *Gemini* Program Manager Charles W. Mathews earlier pointed out that the *Gemini 6* launch behind the *Gemini 7* will depend on the extent of damage to the launch pad. On all previous missions, the damage has been slight, he said.

The *Gemini 7* spacecraft will be equipped with an L-band radar transponder to be located in the noise section with a spiral antenna. Flashing acquisition lights will be located on the adapter, Mathews said.

During rendezvous, the *Gemini 7* spacecraft will point its small end continuously at the approaching *Gemini 6* spacecraft to keep the radar transponder antenna pattern in the best position during interrogation by the *Gemini 6* radar. Borman said that about 20 lbs. of fuel has been reserved for station-keeping or formation flight after the rendezvous.

- **Non-medical experiments**—Experiments to be performed during the *Gemini 7* flight include several not flown on previous *Gemini* missions.

Star occultation measurements, sponsored by the Dept. of Defense, evaluate a technique for determining orbital position against the inertial background without assistance from the ground. The pilot will track six stars of known mag-

Proposals Due Shortly On Orbital Scanner Plan

NASA has issued a request for proposals for preliminary design of an orbital scanner that would greatly increase the accuracy with which the horizon can be defined from space vehicles. Thirty-three firms have been invited to bid on the project, proposals being due by Nov. 16.

Information sought by the orbital scanner, which may be either a satellite or a series of ballistic probes, will include: measurement of the absolute radiance profile of the Earth, including tangent heights from 80 km above to 30 km below the true Earth horizon; the spectral region from 14 to 16 microns (carbon dioxide absorption); determination of radiance profiles from 2 km vertical to 25 km horizontal; determination of the spatial pattern of the wedge of atmosphere being viewed; and a viewing altitude in excess of 150 km.

The successful contractor will work in two phases; the first being a study of all technical factors involved, as well as an initial evaluation of flight techniques, and the second phase being preliminary design of spacecraft systems, analysis of ground support requirements, and supporting cost analysis.

Approaches for obtaining the necessary data, by means of ballistic probe or satellite, will be covered in the second phase.

nitude and will record the time each becomes occulted by the Earth's atmosphere to exactly 50% of its established magnitude.

The photoelectric occultation telescope in this experiment will also be used to obtain basic contrast data on a number of landmarks proposed as guidance and navigation reference points for *Apollo* lunar missions.

An attempt will be made to voice-modulate a laser beam from the spacecraft to ground receivers at Ascension Island and in Hawaii.

Repeated from earlier flights will be terrain and weather photography, radiometric observations of space and ground objects (including missile launches), and a test of visual acuity using ground targets at Yuma, Ariz., and Carnarvon, Australia. The crew will make star-to-horizon measurements using a space sextant and will measure the strength and direction of the Earth's magnetic field for basic data on trapped radiation in the South Atlantic geomagnetic anomaly.

- **Medical tests**—At an earlier press conference, Dr. Charles A. Berry, who heads the center's medical programs, detailed the medical experiments aboard *Gemini 7*. They include:

Cardiovascular reflex conditioning—Lovell will wear pneumatic cuffs around his thighs for 14 days to stimulate the reflex action of blood returning from the lower extremities. Experimenters hope to determine whether in-flight conditioning has an effect in preventing post-flight orthostatic hypotension.

A similar experiment during *Gemini 5* brought inconclusive data because the gas supply in the cuff-inflation system ran out after the fourth day.

Using spacecraft oxygen, a programmer will control inflation to 70 mm of mercury in rhythmical operation every six minutes, pumped up for two minutes, then bled off during remaining four minutes.

Human otolith function—This experiment attempts to measure changes in the gravity sensors of the inner ear (otolith) brought about through prolonged weightlessness. Each man will take turns looking through a special vision-testing device at a light source in the form of a movable white line. By turning a calibrated knob, he will attempt to align the light to what he believes to be the pitch axis of the spacecraft. The other man will read the value on the knob and record it. Data will be compared to pre- and post-flight readings for indication of changes caused by weightlessness.

Calibrated workload—During in-flight exercises, a device of calibrated workload (72 ft.-lb.) will be used to determine the pilot's physical condition during the two-week mission. The purpose of the experiment is to assess each man's general capacity for work under spaceflight conditions. The time for the heart rate to reach pre-work levels following exercise is considered by the experimenter to be an index of the general physical well-being of that subject. A blood pressure reading will be taken immediately before and after exercise.

In monitoring heart response to exercise on both previous long-duration missions, Dr. Berry reported that "the heart has been able to respond in the same manner (returning to normal within the same time periods) at the end of the mission as it did at the beginning of the mission."

Phonocardiogram—The phonocardiogram experiment attempts to evaluate a bioinstrumentation technique for observing the condition of the heart in the spaceflight environment. An indication of heart muscle fatigue, according to the experimenter, can be measured by the time interval between the electrical activation of the muscle (electrocardiogram) and the onset of muscular contraction (heart sound).

Soviet physiologists have reported the time interval increased considerably in their cosmonauts during long space flights; however, to date, "we have found no observable difference—delay or shortening of period between the electrical impulse and the mechanical contraction itself," Dr. Berry said.

Bone demineralization—Through a technique called "X-ray densitometry," researchers have been able to observe a change in bone mass that can be attributed to the space environment. Loss of calcium has been detected through X-rays of heel bones and end bones of the fifth fingers on the right hands taken before and after earlier flights. "We are highly interested in getting some data on total calcium balance within the body to add to this information." Berry says.

Calcium and body fluids balance studies—Up to 112 urine samples will be collected by the crew during the two-week mission for post-flight analysis. The calcium content of waste products will be carefully measured and recorded. Before the flight, the crew will follow a prescribed diet to control the daily calcium intake to 800 to 1,000 milligrams for 10 days. During this time, the men will submit to distilled water sponge baths to obtain a meaningful indication of calcium loss through perspiration. To round out the balance studies, baseline data will be collected for four days after the mission. ■

S-II Test Stage Goes Into Tower at MTF

NOW BEING readied for development testing early next year is this near-duplicate of flight versions of the S-II second stage of the Saturn V, recently arrived at Mississippi Test Facility. Dubbed S-II-T, the million-lb.-thrust, liquid hydrogen stage is the first rocket to arrive at the new installation.

Von Braun Urges Reusable Transport

Marshall director reports on studies of vehicle using either ramjet or nuclear first stage; other highlights of ISES

by Charles D. LaFond

MIAMI BEACH—A reusable Earth-to-orbit transport vehicle, possibly employing a supersonic-combustion ramjet first stage with a liquid-engine second stage, will be needed in 10 to 15 years when the density of traffic to space stations increases sufficiently.

Such a system would include launch vehicle and spacecraft both "capable of returning to Earth in a lifting-flight mode," says Dr. Wernher von Braun, director of NASA's Marshall Space Flight Center.

His description of the system was presented during a panel discussion of "Future Space Programs" at the 1965 International Space Electronics Symposium held here last week under the sponsorship of the Institute of Electrical and Electronic Engineers. He stressed the increasing importance of reusability in improving launch vehicles' cost-effectiveness.

Von Braun said MSFC studies indicate that development of a reusable system capable of placing a 10,000-lb. payload plus 10 men in orbit would cost about $1 billion. If it were designed to perform one mission per week and be equal to 50-100 flights, net payload-to-orbit cost might be lowered to less than $50 per lb., he predicted.

Two systems approaches have been studied, he said. In the second, the system would employ a nuclear-powered first stage with a liquid second.

• **Voyager needs**—Also speaking on the Future Space Programs panel, Dr. William H. Pickering, director of the Jet Propulsion Laboratory, disclosed the need for an automatic terminal guidance system in *Voyager* vehicles.

He said that communications problems during a three-year mission to Jupiter would be further enlarged by the 30-minute transmission delay time from Earth to *Voyager* as it approached the planet. To command and verify ground-directed terminal guidance instructions would require over one hour.

Landing problems through an unknown atmosphere and onto an unknown surface further complicate the guidance problem. Communications to Earth after landing will be difficult and a minimum data rate output from on-board instrumentation will have to be considered, he said.

• **Holography pressed by ERC**—Research will be steadily increased at NASA's Electronics Research Center in Cambridge, Mass., for potential applications of holograms in both inner and outer space and in the atmosphere, ERC director Dr. Winston E. Kock told an ISES luncheon group.

The unusual attributes of holographic plates, using the laser as light source, provide a pictorial image having far greater information than several groups of stereo photographs, he said. Such representations of the lunar surface, as well as other planets on which man may someday land, would be of incalculable benefit for both astronaut briefing and scientific use.

Because of bandwidth limitations for space transmissions, Kock disclosed, ERC also will study the use of microwaves for holography in space, although the final pictorial representation would show less detail. A second and equally important use of the microwave approach may be in the atmosphere for the study of clear air turbulence (CAT). If successful in the detection of CAT, Kock told M/R, there is no reason why such pictures could not be obtained in flight for pilot warning of such conditions. He said the University of Miami has been given a preliminary research grant from ERC that ultimately may lead to such a study effort.

Kock also discussed with M/R the application of acoustical holograms to the *Apollo* tracking vessels. At present, he said, they will be situated at sea over positions carefully charted beforehand with respect to the ocean floor. Regular sonar soundings, compared with previously stored sea-bottom information, will help pinpoint the ship's location.

But he asserted that if an acoustical holographic presentation of the sea floor could be obtained at will, a more accurate determination of ship's position would be possible.

• **"Hot electron" advances**—ERC is expected to report publicly in the next few months a major advance in the application of hot electrons to solid-state transmitters, Kock said. The work has resulted from the center's efforts to increase space radio transmitter efficiency. Kock said a paper will be published by Dr. Harold Roth describing successful solid-state generation of continuous wave signals at X-band (using the gun effect). Bulk semiconductor material, measuring less than 0.001-in. thick, was used rather than conventional epitaxial material, Kock disclosed.

Although transmitting efficiency using the new approach will certainly be high, the ERC director indicated that the magnitude of increase has not yet been determined.

• **New tape recorder**—Hewlett-Packard Company used the ISES for a first showing of its new 1.5-mc magnetic tape instrumentation recorder, probably because of the high percentage of Eastern Test Range and Eglin AFB personnel in attendance.

As a sounding board, the symposium's increased attendance left little to be desired; the low cost and high performance of the new 3950 series were reportedly well received.

The recorders employ 15-in.-dia. reels and either 7 or 14 channel tapes. Simplification of design with the elimination of costly extra functions was followed faithfully throughout development of the recorders. Tape speed, transport operation, and playback equalization are controlled by push-buttons.

The result, according to John Young, H-P's Microwave Division general manager, is a new series of recorders built from the floor up that in general equal or outperform most existing high-performance recorders. Cost of the largest of the series is under $20,000 (as compared to others in the $50,000-70,000 range).

• **Performance characteristics**—The firm is maintaining a conservative approach to electronic performance of the recorders until a heavier backlog of test data are available, said Walter Selsted, who directed development of the equipment. He does claim a signal-to-noise ratio of better than 26 db in the 400-cps to 1.5-mc band.

Square-wave rise time, he stated, is less than 0.4 microsec., and typical signal-to-noise performance is about 33 db. Distortion from electronic sources is more than 50 db below peak level. Selsted pointed out that this performance is maintained despite random interchange of solid-state record/reproduce plug-in amplifiers.

In describing motional stability of the recorders, Selsted disclosed that typical flutter is less than 0.2% peak-to-peak when measuring all components from dc to 1.5 kc. ■

Recoverable Booster Studies Aired

Recently published testimony shows Congressional interest in development of rocket-propelled and air-breathing systems

NASA WORK applicable to development of recoverable launch vehicles is now funded at about $12 million, Dr. Raymond Bisplinghoff has told Congress. He is associate administrator for the Office of Advanced Research and Technology.

In additions just made to testimony before the Senate Aeronautical and Space Sciences Committee on "National Space Goals for Post-*Apollo* Period," Bisplinghoff said there are now two groups working on recoverable boosters. One of these is in the Aeronautics and Astronautics Coordinating Board, and another drawn from OART and the Air Force Systems Command.

The current effort in OART, Bisplinghoff said, is $10 million, 10% of which is for flight tests, and the rest for ground-based research. This ground-based research is about equally divided between winged vehicles using rocket propulsion and auxiliary devices, and winged vehicles using air-breathing propulsion.

The Office of Manned Space Flight also has planned a supporting research and technology program on auxiliary devices amounting to about $2 million. Considerable interest has been evidenced by Congress in research on re-usable booster technology, and recommendations to speed up such efforts were made in Senate Space Committee reports accompanying budget legislation this year.

- **First step**—The most immediate way to accomplish booster recovery, Bisplinghoff said, probably is through use of auxiliary devices. Such devices could probably be integrated into present-type launch vehicles, but with some vehicle redesign, he indicated.

Hot-air balloon systems are now being investigated for spacecraft and booster recovery, and while they are directed primarily at the 10,000 to 30,000-lb. class, he said, the technology developed will be applicable in many respects to launch vehicles weighing up to 300,000 lbs.

Studies of how to protect the vehicles from the heat of re-entry also are under way at NASA research centers as part of investigations of spacecraft ablation heat shields, he said. These include replaceable panels or spraying to rapidly refurbish the heat-protection system material.

- **Projects suggested**—Bisplinghoff suggested that an actual launch vehicle should be used to gain engineering and operational experience on the full spectrum of problems, including flight, re-entry heating, exposure to salt water, retrieval, and refurbishment of the vehicle to a flight status.

He also suggested using simulated vehicles to study effects of salt-water immersion on critical launch vehicle components.

He pointed to the commonality of technology existing between the winged, re-usable launch vehicle, and hypersonic cruise aircraft concepts now under study by NASA. Lifting body research also shows these systems have potential for use as upper stages for recoverable launch vehicles.

The Air Force also has concluded studies that show a supersonic transport could be used as a first stage for a recoverable orbital booster.

- **Other advanced studies**—A number of study contracts in the advanced missions category, which were listed in the Fiscal Year 1965 budget but have not been issued, were listed by Dr. Robert C. Seamans, NASA associate administrator.

A total of $8.9 million was set aside for *Apollo* Extension Systems (now *Apollo* Applications) experiments, although only a few studies were let. The remaining ones include those for preliminary design of the *Apollo* Command and Service modules for AA experiment definition and design studies, definition of an experiment program in space operations techniques/subsytems; definition of an experiment program in advanced technology and subsystems; Earth orbital space science experiment program definition, and atmospheric science and technology experiment program definition.

Others include studies of a communications experiment program definition, navigation/traffic control experiment program definition, and AA experiment systems integration studies.

Two other Earth orbital studies, for the *Applications Technology Satellite ATS-4* and a direct FM broadcast satellite, also have not been issued. Total funds for miscellaneous Earth orbital studies were set at $1.25 million, with another $1.2 million for the *Manned Orbital Research Laboratory* space station definition contract held by Douglas, and $3.7 million for preliminary design for Lunar Excursion Module modification and systems engineering for the AA program.

Lunar studies, all of which total $8.4 million, include uncommitted studies on simulation of the orbital mission, advanced spacesuit evaluation, scientific mission support for extended lunar exploration, mission modes and systems analysis for lunar exploration, lunar surface mobility systems comparisons, and early lunar shelter designs.

In the planetary and interplanetary category, for which $2.3 million was earmarked, uncommitted studies included interplanetary and solar probes, low-acceleration space transportation planetary systems, and an unmanned Jupiter fly-by and orbiter.

For launch vehicle improvement, for which $3.1 million was set aside, there remain *Saturn* improvement, re-usable multi-mission aerospace transport, kick-stage design, and advanced recoverable launch vehicle studies.

In the aeronautics field, at $900,000, there are studies on the feasibility and operational study of short-haul transports, and the synthesis of long-range hypersonic aircraft. ■

Apollo Applications RFP Due Before Christmas

WERNHER VON BRAUN, director of NASA's Marshall Space Flight Center, has disclosed that requests for proposals for systems definition of payload integration for the *Apollo* Applications program will be issued "before Christmas."

Officials at NASA headquarters also declared last week that the RFP could be sent out as early as late this month or early December.

Space agency plans call for Marshall, which will issue the RFP, to be responsible for payload integration of all experiments to be carried in the Lunar Excursion Module. This will comprise by far the largest portion of AA experiments.

The Manned Spacecraft Center will be responsible for mission operations as well as for integration of payloads into the Command and Service Modules.

ASW Missile Test Site Readied

Built-in gun systems at new NOL tank will propel advanced model shapes at water-entry speeds twice that of Subroc

by Michael Getler

WHITE OAK, MD.—Scale-model testing of advanced ASW missile shapes will begin late next summer at the huge new hydroballistic tank under construction at the Naval Ordnance Laboratory here.

Using a variety of built-in gun systems to propel the models into the 100-ft.-long, 65-ft.-deep, 35-ft.-wide tank, Navy experts say they will be able to fire them into, through, and out of the water at speeds far in excess of those achieved with contemporary ASW weapons.

NOL scientists say they have already come up with what they consider to be "a big improvement" in missile shape and that scale model testing of the design awaits only completion of the tank, now set for June, 1966.

Dr. Arnold Seigel, chief of the Ballistics Dept. at NOL, reports that using a 3-in.-dia., 18-in.-long, ⅙-scale model, water-entry speeds of at least 3,000 fps will be possible. This is twice the velocity at which the Navy's *Subroc* ASW missile re-enters the water. The ⅙-scale model corresponds roughly to a *Subroc*-class weapon.

The facility will also allow launching larger models, up to 6 in. in diameter, at entry speeds to 1,000 fps.

In preparation for other future needs in ASW weapons, the tank and launch systems will also allow experimenting with very-high-speed underwater missile travel to velocities as high as 2,000 fps, estimated to be some 10 times faster than current weapons travel. Also, water exit velocities to 600-1,000 fps, forseen by NOL scientists as the maximum for future weapons, will be possible with the advent of the new equipment.

● **Facility justification**—In making its case for construction of the $3.86 million facility, NOL drew heavily upon the recent urgency attached to the ASW problem, the high cost of prototype testing, the advent of *Subroc* class weapons, and the history of the development of that weapon.

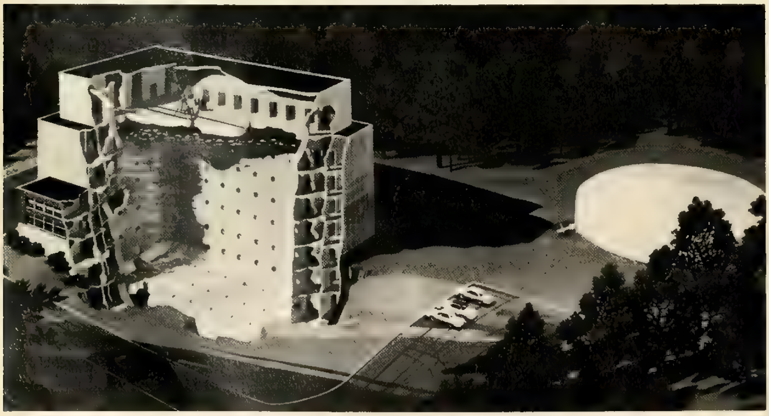
Although *Subroc* has now proved its feasibility, it has also made a strong case in NOL's view for a greatly increased Navy capability for hydrodynamic testing, particularly high-velocity water entry, prior to prototype construction.

The original design of *Subroc,* according to the Navy, was based on low-velocity (less than 750 fps) water entry data, since these were the only data available.

"Both the predicted entry forces and the predicted shape of the cavity created at water entry were thus extrapolations. When full-scale models of *Subroc* were first tested at velocities up to 1,500 fps," an NOL report states, "every model failed at water entry."

The resultant redesign and additional full-scale testing, NOL argued, "represented expenditures of several hundred thousand dollars which could have been largely avoided had there existed an adequate hydroballistics tank facility."

CUTAWAY drawing suggests size of NOL's new ASW missile-testing tank facility.



Because of experience with *Subroc,* and also to a certain extent with the LULU nuclear depth-charge developed by NOL, Navy scientists now state emphatically that the impact forces and the shape of the cavity formed by impact, which actually determines the stability of the missile, can not be extrapolated from low-velocity results to apply to a high-velocity missile design.

● **Tank design**—The new NOL tank will be equipped with four to five gun systems (and fifteen 36-in.-dia. gun ports) employing both conventional powder charges for firing the models and compressed air units for slower speed launchings. The guns will be equipped with specially designed sabots (which hold the model in the gun prior to firing) that will prevent either launch shocks or powder particles from entering the tank.

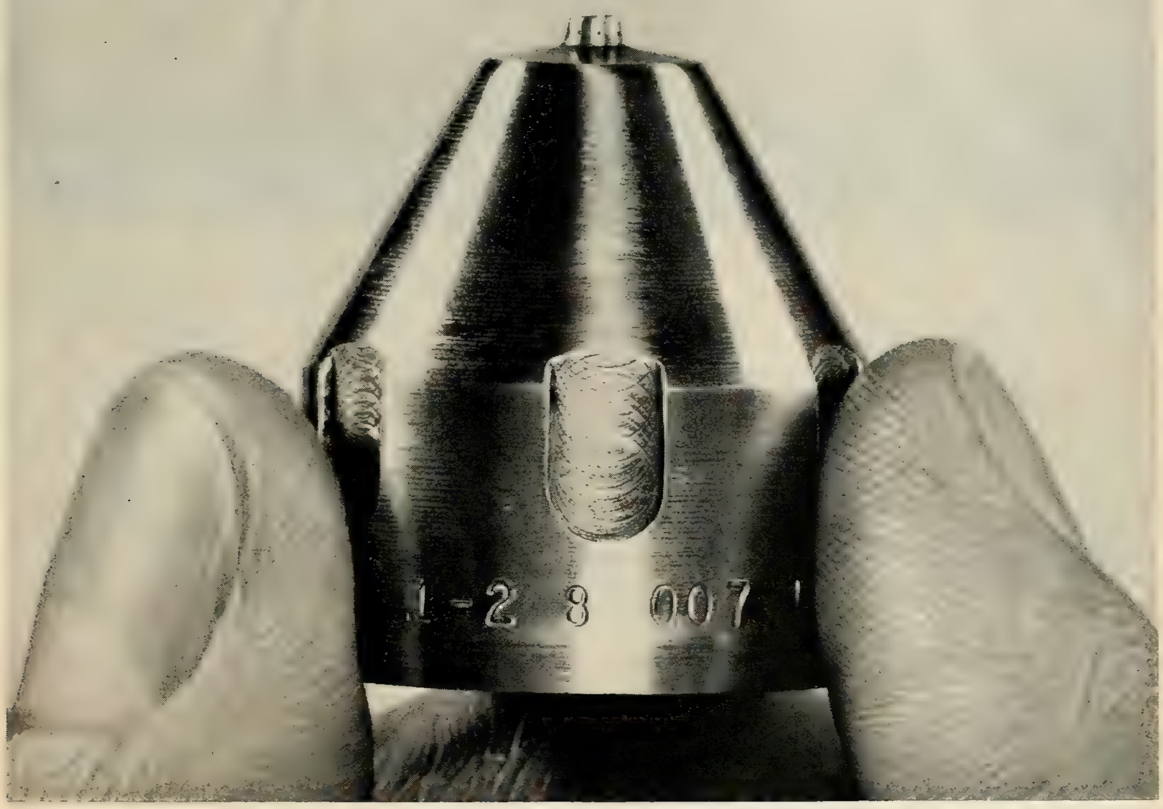
Guns are placed above the water for firing down into it, at one end of the tank, and at the bottom for exit tests. The guns will allow underwater launch at any angle through the air-water interface. There also will be a movable launcher within the tank for simulation of firing from a moving submarine.

● **Air pressure variable**—In order to get as many operational inputs as possible into scale model testing, the tank will also be equipped with a steam-ejector vacuum system that will allow reduction of the air pressure above the water level.

Under normal conditions, entry of a 20 to 30-ft.-long missile into the water would result in changes in pressure, possibly as much as one atmosphere, between the time it impacts and the time that the entire missile is in the water. This also affects stability and trajectory. Reducing the pressure of the air above the water, rather than altering water pressure, will allow simulation of this effect when using the short scale models.

In addition to gun modifications designed to keep out contaminating particles, the tank is designed with a ⅛-in.-thick, non-corrosive stainless steel lining covering the 14-in.-thick reinforced concrete walls. Water free of any contamination or suspended particles is required for high-speed photography of missile activity. The tank's filtration system actually includes a second complete reservoir. ■

Cleaning these microscopic spray holes of fuel injector cups was a critical problem at Cummins.



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The fuel injector cup is the heart of the diesel fuel system made by the Cummins Engine Company of Columbus, Indiana. Each cup has five to nine spray holes as small as .005″ in diameter. The tiniest speck of dust can clog one of these holes and ruin the efficiency of the entire system. Reducing its rejection rate became a major goal at Cummins.

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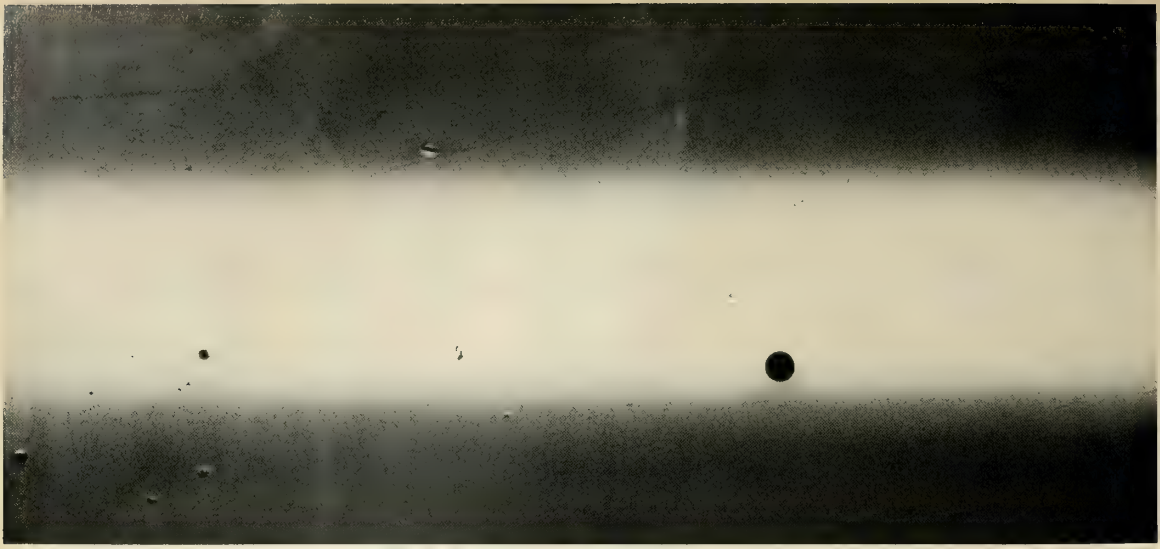
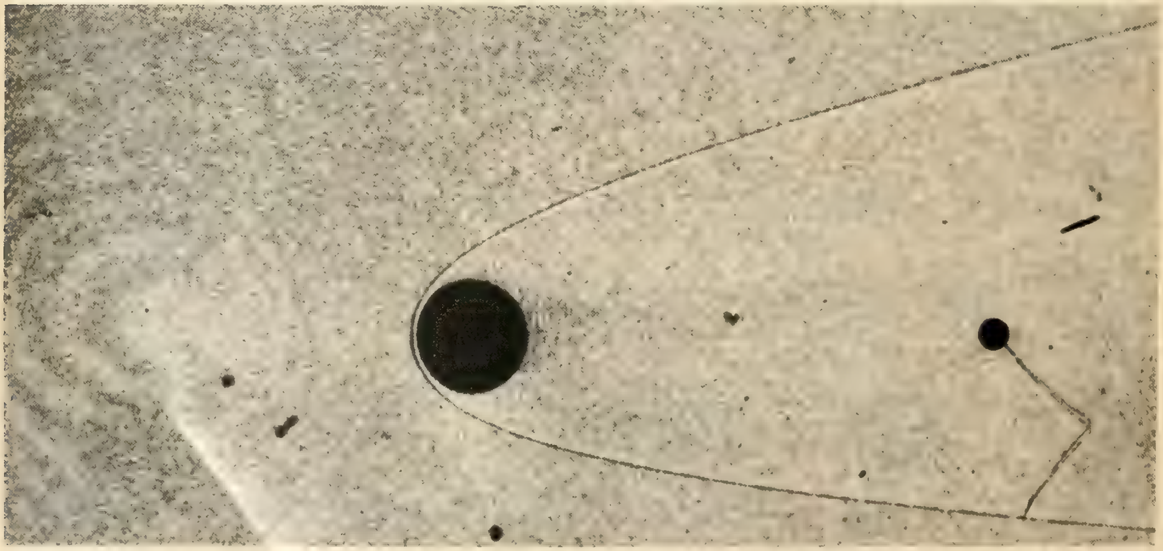


NOL Uses Laser Light to Get Clear Test Pictures

WHITE OAK, MD.—This amazing pair of photographs, believed to be the first of their kind, demonstrate a new and unique application for laser light sources in ballistic missile research.

The photos are of a 1-in. Lexan sphere traveling at 16,000 fps through the 1,000-ft.-long hyperballistics range at the Naval Ordnance Laboratory here. Actually shadowgraphs, they were made at instrumentation stations 20 ft. apart in the enclosed, 70-ft.-wide test range. The top photo was made from a conventional shadowgraph station, using spark illumination of microseconds' duration. Overexposure of the photo, which hides the sphere and all but a small portion of the accompanying shock wave, is caused by the additional light given off by the burning and ablating model. The bottom photo was taken using a solid-state, Q-switched ruby laser as a light source in combination with a narrow-band pass filter in the camera lens system. This filter allowed only the short-duration laser pulse to strike the film, resulting in a clear and sharp image of the body and the shock wave. The smaller black spheres on each photo are stationary reference points in the chamber.

The laser, built by Laser Systems Center, a subsidiary of Lear Siegler, Inc., has a pulse duration of less than 30 nanosec. NOL scientists are enthusiastic about its performance and are working towards incorporating a permanent station in the range. The NOL range, using two-stage light-gas guns for propulsion sources, is capable of firing missile models to speeds exceeding 30,000 fps. ■



time & space

...The time is short, if the U.S. is to achieve its goal of landing the astronauts on the lunar surface in the late sixties. Grumman Engineers, working in the space sciences, are pressing forward on the LEM (Lunar Excursion Module) program to meet this schedule.

No amount of enthusiasm 'cranked-in' to a program could explain the personal enthusiasm that our engineer-scientists have for it, nor the motivation that makes them our best recruiters. A large part of the LEM group has been brought in from the outside by these engineers as they 'buttonhole' friends, college classmates and association brothers to join LEM, designated by many as the greatest technical challenge of our times. Space takes on a deeper dimension for all concerned, since LEM is the first manned vehicle being developed to operate *solely* in outer-space.

Further U.S. commitments to manned space travel will undoubtedly hinge on the success of this endeavor. When this happens, those responsible for it will stand poised for the next rung up the ladder of space technology. The LEM program is young. If you're qualified, we have the space for you. The time is now!

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Cryogenic Engineers—B.S. in Engineering with experience in development, analysis & design of cryogenic gas storage supply, including related temperature & pressure control systems.

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Stress Analysis Engineers—Structures Engineers to participate in the design of aircraft, missiles, spacecraft & other vehicles. Duties include: participation in the arrangement & optimization of the structure, providing the designers with internal loads, & conducting the structural analyses to substantiate the design. A working knowledge of the basic methods of stress analysis including the fields of plates & shells, redundant structures & fatigue strengths is desired. BS or MS in AE, CE, ME or Applied Mechanics or equiv exp & education is prerequisite. Both Junior & Senior positions available.

Liaison Engineers—BS or equivalent with experience in aircraft design & a good practical knowledge of production fabrication methods & drafting procedures. Must have ability to analyze production difficulties & develop & carry through necessary engineering revisions. Both Sr. & Jr. level positions available in all aerospace systems.

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Weight Analysis Engineers—B.S. or B.A. in Mathematics and a minimum of 3 years experience in Aerospace Structural or Systems Weight Control. Strong background in computation and analysis of weight and moment of inertia as well as experience in maintaining records, preparing reports, actual weighing procedures, flight test support, and analysis of weight-trade-off studies are required.

Weight Optimization Engineers—Experienced design, stress, electronic engineers to originate and contribute to the development of practical minimum weight design and conduct trade-off studies for vehicle weight optimization. Will also carry out weight control during design and production of aerospace structure and systems. BS and 5 years aerospace experience within your specialty & general engineering competence are required.

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(Additional opportunities in space as well as aircraft & ASW programs, on following page)

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(Continued from previous page)

Human Factors Engineers—MA or PHD in Experimental Psychology with at least 2 years Human Factors experience. BS in Engineering with appropriate experience will be considered. Positions are available in Aircraft Systems Analysis, Display & Control Design, Cockpit Layout, Design for Maintainability, Training Requirements, Training Devices and Experimental Studies.

Mission Analysis Engineers—Plan LEM missions and determine related spacecraft functional requirements. Normal and emergency operations during both development and lunar landing missions are to be considered. The work will involve contact with engineering and test sections at all levels. A minimum of 5 years experience, preferably in systems analysis, preliminary design or operation analysis is required.

Senior Programmer—Three to five years programming experience on general purpose equipment with an applications background in the scientific fields of systems simulation, real time programming, math, modeling, systems analysis and differential equations. BS in science, Mathematics or Physics as a minimum. Desirability for a strong engineering orientation in systems analysis. Complete programming knowledge of the IBM 7094 including FORTRAN, and FAP languages.

Attack and Reconnaissance Systems Engineers—BS or advanced degree with a minimum of 3 years experience in overall development of airborne attack and reconnaissance systems. Knowledge of components which comprise these systems such as analog and digital special purpose computers, displays, sensors including radar, inertial platforms, IR and visual or photographic inputs, guidance and control, and autopilots is essential. Duties include: definition of the requirements for the systems, analysis and synthesis of the systems, simulation, and flight development for final verification.

Missiles Systems Engineers—BS or advanced degree with a minimum of 3 years experience in analyzing, integrating, interfacing and developing air launched missile systems. Must be familiar with homing and guidance concepts, control mechanization, kill mechanisms, analytical tools for determining effectiveness, radar techniques, and aircraft interface requirements. Positions encompass interpreting aircraft requirements, evaluating effectiveness, determining interface compatability, and planning and interpreting flight evaluation.

Systems Co-ordination Engineers—will coordinate a program that organizes, validates and controls the overall functional requirements of an advanced manned spacecraft project fulfilling project objective as prescribed by the procuring agency. These functional requirements are translated into over-all vehicle performance and design requirements, establishing systems parameters from which the vehicle, its major subsystems, and support equipment are designed. Task assignments include: internal and external liaison with design specialists & systems personnel & direction of the incorporation of established requirements into top systems and vehicle specifications. Applicants should possess a BS or MS in ME, EE or Physics and a minimum of 3 years of systems analysis or integration experience in a major systems effort.

Carrier Suitability System Engineers—BS or advanced degree with minimum of 1 year experience in establishing operational compatibility of a given weapon system with ship facilities and ship installations. Operational experience is highly desirable. Will establish high density and/or mixed compliment aircraft spotting characteristics, investigate aircraft and ordnance handling, and verify the compatibility of related support equipment and facilities with the aircraft carriers concerned and/or other operational sites and vehicles.

ASW Systems and Operations Analysts—B.S. or M.S. and a minimum of 2 years appropriate experience. Duties: determination of ASW weapon system and sub-system functional requirements and performance objectives; formulation of mathematical models and design of experiments; optimization techniques for multi-dimensional response surfaces; definition of expected environments and evaluation of their effect on performance; evaluation of total system performance; system integration.

Systems Engineers—Facility and Services—BS or advanced degree with a minimum of 2 years experience in establishing the requirements for facilities and the criteria for the evaluation of existing facilities. Applicants will be required to survey tests and operational sites both ashore and afloat to verify weapon system compatibility with existing facilities and support equipment. Ability to recommend and/or originate solutions to preclude potential interface difficulties is necessary. Recent military experience and/or good working knowledge of military organization desirable.

Liquid Propulsion Reliability Test Engineers — BSME with 3 to 5 years experience in testing, and development of liquid rocket engines. Experience should include familiarity with hypergolic propellants. Will monitor development and qualification test programs for Reliability including specifying environmental test requirements (climatic and dynamic), negotiating requirements with subcontractors, reviewing test plans and test data, reviewing and assessing test results. Reliability experience is desirable although not mandatory.

NOTE: Positions also available in the above areas to February or June '65 Engineering Graduates

Use the attached inquiry form to arrange a mutually convenient interview.

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PROFESSIONAL PLACEMENT INQUIRY

For your convenience and to facilitate your inquiry, please use this form. It will enable the professional staff at Grumman Aircraft to evaluate your background and experience and arrange for a mutually convenient personal interview. All inquiries will be held in strictest confidence. Enclose in an envelope and send to Mr. **P. M.** Van Putten, Manager, Engineering Employment, Dept. **GR 86**, Grumman Aircraft Engineering Corp., Bethpage, L.I., N.Y.

NAME__________

STREET ADDRESS__________

CITY & STATE__________TELEPHONE__________

NEAREST MAJOR CITY (IF APPLICABLE)__________

COLLEGE GRADUATE: YES___NO___

Degree	Subject	Year

Major Specialty__________Yrs._____Other Specialty__________Yrs._____

Applying for position(in)(of)__________

Background and experience (Brief resume of experience, recent history of employment. If available, attach prepared resume.)

Circle No. 6 on Subscriber Service Card

ASTROLOG

Current Status of U.S. Missile and Space Programs

satellites and spacecraft

ADVANCED ORBITING SOLAR OBSERVATORY (NASA)

Republic, prime. DESCRIPTION: 1,250-lb. spacecraft to make detailed measurements of Sun's radiation; greater pointing accuracy (5 arc sec) than OSO; launch vehicle, THRUST AUGMENTED THOR-AGENA. STATUS: Development funding in FY '66 budget; two spacecraft to be launched in 1969, two in 1971.

APPLICATIONS TECHNOLOGY SATELLITE (NASA)

Hughes, prime; GE, gradient stabilization. DESCRIPTION: Five-satellite program to test communication and meteorological equipment in medium and synchronous orbit; test bed for gravity gradient communications and meteorological experiments; weight, 780 lbs.; launch vehicle, ATLAS-AGENA. STATUS: Development; first flight scheduled for late 1966.

APOLLO (NASA)

North American, Command & Service modules, systems integration; Grumman, Lunar Excursion Module (LEM); MIT, guidance development; AC Spark Plug, guidance prime; Collins Radio, telecommunications; Honeywell, stabilization & control; AiResearch, environmental control; Northrop-Ventura, parachute recovery; Lockheed Propulsion Co., escape tower rocket; Marquardt, reaction controls; IBM, realtime computer complex; Westinghouse, power conversion equipment. Lunar Excursion Module, prime, Grumman; descent engine, TRW Systems Group; ascent engine, Bell Aerosystems; environmental control, Hamilton Standard; reaction control thruster, Marquardt; guidance, MIT; radar & communications instruments, RCA; TMC, telemetry, Radiation Inc.; fuel cell, Pratt & Whitney; external visual display, Forand Optical; GE, acceptance checkout reliability; rendezvous optical system, Hughes. DESCRIPTION: Three-man spacecraft for Earth-orbital, lunar-orbital and lunar-landing missions. Boosters: SATURN I and SATURN IB for Earth orbits; SATURN V for lunar rendezvous and landing missions; 3-modular spacecraft: Command Module weight, 5-1/2 tons; Service Module, 25 tons; Lunar Excursion Module, 15 tons; total weight, 95,000 lbs. STATUS: First of a series of unmanned orbital tests began with a boilerplate model launch of SA-7, Sept. 18, 1964; LITTLE JOE II unmanned abort test successful, Dec. 8, 1964; first flight-rated spacecraft to be launched January 1966; lunar orbits scheduled 1968; lunar landing by 1970; first manned orbital flight due last half of 1966.

APOLLO APPLICATIONS (NASA)

No contractors named. DESCRIPTION: APOLLO spacecraft would be modified to provide extended life support and battery capability; two tanks would be removed from the Service Module propulsion section to provide room for additional consumable supplies; ascent stage of Lunar Excursion Module for extended operations in lunar orbit and on the lunar surface; many experimental payloads have been proposed, including orbiting telescopes, survey, mapping communications and many others. Boosters: SATURN IB and SATURN V. STATUS: RFP for preliminary program definition for the payload integration work is expected to be issued before the end of the year; 20 flights are planned beginning in late 1968.

ATHENA (Air Force)

Atlantic Research, prime; Honeywell, guidance. DESCRIPTION: 17,500-lb. four-stage re-entry vehicle, attains apogees from 600,000 to 1,000,000 ft.; last two stages drive vehicle and payload Earthward at near-ICBM velocities; major diameter, 32 in.; velocity package diameter, 28 in.; length, 51 ft. First-stage engine, Castor XM33 (Thiokol); second stage, either X261 (Thiokol) or X259 (Naval Propellant Plant); third stage, 30KS 8000(Aerojet); fourth stage, Ranger Retro BE3, Hercules. STATUS: Engaged in sub-scale testing of advanced re-entry concepts; 77 launches scheduled; last flight Sept. 13; 10 of last 13 successful.

BIOSATELLITE (NASA)

GE, prime. DESCRIPTION: 1,000-lb. satellites to test effects of space environment on plants, animals (primates) and other biological specimens; launch vehicle, THRUST-AUGMENTED DELTA. STATUS: Six flight models to be built; first flight in mid 1966; others to follow at three-month intervals; 14 experiments selected for first flight.

COMSAT CORP. SATELLITE PROGRAM

Proposals from Hughes, RCA and TRW/ITT for advanced satellite for world-wide system under consideration; 240-lb. spacecraft would have capacity for 1,000 two-way voice circuits and be able to be launched into synchronous or medium-altitude orbits singly or in groups of four to six by single rocket; system to be operational by late '67 or early '68. Corporation also working on system for use with APOLLO program and commercial communications; Contracts to be let to Hughes for synchronous satellites and Page Communications Engineers for transportable ground stations; systems to be operational by late '66; EARLY BIRD, experimental/operational satellite built by Hughes, launched April 6 and now in synchronous orbit over Atlantic, transmitting between U.S. and Europe.

DISCOVERER (Air Force Program 622A)

Lockheed, prime; GE, re-entry vehicle. DESCRIPTION: THOR-AGENA and ATLAS-AGENA launchings of stabilized satellites; main purpose is to test techniques and components for military space systems. STATUS: All data on program classified as part of DOD information policy; however, indications are that program has been cut back or ended as more economical vehicles have come into use.

ECHO (NASA)

Langley Research Center, prime. DESCRIPTION: ECHO I ,135-ft. inflatable sphere in 700- to 805-mi. orbit; passive communication satellite; booster, THOR for ballistic tests; THOR-AGENA for orbital. STATUS: Program complete; ECHO I in orbit since Aug. 12, 1960; two ballistic shots in 1962 unsuccessful; ECHO II launched from Vandenberg Jan. 27, 1964; U.S.-USSR conducting experiments using ECHO.

GEMINI (NASA)

McDonnell, prime; Rocketdyne, spacecraft propulsion; General Electric, fuel cell; IBM, guidance system integration and computer; Honeywell, guidance; Westinghouse, rendezvous radar; AiResearch, environment. DESCRIPTION: Bigger and heavier MERCURY-type capsule to carry two men for up to two weeks; TITAN II used as booster; ATLAS-launched AGENA will be used for rendezvous missions; 15 spacecraft will be produced. STATUS: Development; 12 flights planned; will be used to determine feasibility of rendezvous for lunar mission and long-duration manned flight; first unmanned flight, April, 1964, successful; second unmanned orbital flight, January, 1965, successful; first manned flight successful March 23; second flight successful, June 3-7, 1965, including first extravehicular activity; eight-day GEMINI V flight, Aug. 21-29, set world record for manned spaceflight duration; GTA-6 mission postponed until next year when Oct. 25 rendezvous attempt scrubbed after Agena failed to achieve orbit; flight may be attempted one week after launch of GT-7; manned and rendezvous flights, 1966-67; AF participating in program, and will modify GEMINI capsule for MOL.

GEOS (NASA)

Applied Physics Laboratory, prime. DESCRIPTION: 350-lb. geodetic satellite (similar to ANNA) to carry flashing-light beacons, electronic beacons and optical and radar reflectors; launch vehicle, IMPROVED DELTA; 700-900-mi. orbit at a 59-degree inclination. STATUS: First flight planned Nov. 2, 1965; PAGEOS passive satellite developed by Langley Research Center will also be launched first half of 1966.

HYPERSONIC RESEARCH VEHICLE (AF, NASA)

No contractors announced. DESCRIPTION: Manned hypersonic spacecraft capable of Earth-to-orbit-and-return; turbofan, Mach 0-3; ramjet, Mach 3-8 or 10 (oxygen collected and liquefied during this cycle); Mach 8-10 orbital speeds, LH_2-LOX rocket. STATUS: Joint NASA-AF research program approved; NASA funding $5 million in FY '66; AF has advanced technology program in six pertinent areas (mostly engine developments) in FY '65. GE, Pratt & Whitney and Marquardt selected for conceptual and preliminary design of a research engine; engine flight test planned for early 1968.

ICBM ALARM (Formerly MIDAS) (Air Force Program 239A)

Lockheed, prime; Aerojet, IR detector system. DESCRIPTION: Early-warning random-orbit satellite; detect ICBM launchings by IR; two flights conducted in 1963 detected solid and liquid missile launches; satellites are launched piggy-back on various AF boosters. STATUS: Development; no decision on deployment; reportedly competing with over-the-horizon radar; Air Force is currently studying requirements for a new, multi-function satellite, combining the functions of MIDAS and SAMOS.

INTERPLANETARY MONITORING PLATFORM (NASA)

Goddard Space Flight Center, prime; Martin Co. developing nuclear power unit. DESCRIPTION: 131-181-lb. satellite launched into cis-lunar-space orbit with an apogee of more than 100,000 mi.; will measure radiation and solar flare hazards in advance of Project APOLLO; launched by DELTA and THRUST-AUGMENTED DELTA boosters from AMR. STATUS: IMP-I launched in December, 1963; IMP-II launched Oct. 3; five more satellites are planned, two to be placed in lunar orbit; later flights will use a nuclear power unit as replacement for solar cells; designation, IMP-A is EXPLORER XVIII; IMP-B is EXPLORER XXI.

ISIS (Canada, U.S.)

Canadian Defense Research Board, satellite; NASA, launch vehicle. DESCRIPTION: Three-satellite follow-on program to ALOUETTE to continue ionospheric studies. STATUS: Design of ISIS A began in 1964 with launch planned in 1967; B and C to be launched in 1968, 1969; launch vehicle, THOR-AGENA.

LES (Air Force)

M. I. T. Lincoln Laboratory, prime; consulting support, TRW Systems Group. DESCRIPTION: a series of Lincoln Experimental Satellites carried as TITAN III-A and III-C "bonus" payloads to test military comsat devices and techniques. STATUS: First launch Feb. 11 failed; second, May 6, achieved orbit.

LUNAR LOGISTICS SYSTEM (NASA)

Studies have been conducted by Grumman, TRW Systems Group and Northrop. DESCRIPTION: Spacecraft to carry support payloads to the Moon. Two designs under study—LEM truck with 7,000-lb. payload and logistics spacecraft with 25,000 to 30,000-lb. payload; booster, SATURN V. STATUS: Program definition of the LEM truck planned in FY '67; program would cost about $1 billion; first step will be to extend lunar stay-time up to two weeks.

LUNAR ORBITER PHOTO CRAFT (NASA)

Boeing, prime; RCA, power and communications; Eastman Kodak, cameras; Marquardt, maneuvering engine. DESCRIPTION: 800-lb. spacecraft launched by ATLAS-AGENA will orbit Moon, taking pictures of lunar surface; radioactive and geodetic measurements will also be taken. STATUS: Five flights scheduled beginning in mid-1966.

MANNED ORBITING LABORATORY (Air Force)

Douglas Aircraft Co., prime; GE, on-board experiments; Aerospace Corp., technical management. DESCRIPTION: Two-man spacecraft to establish military usefulness of man in space; booster, TITAN III-C; GEMINI-X capsule atop 10-ft.-dia., 41-ft.-long canister lab; total weight about 25,000 lbs., orbit below 350 mi.; flights of 30 days in shirt-sleeve environment planned. STATUS: Six-launch program now planned; 30-day missions; 60-90 day missions under study; $150 million in FY '66 funding; unmanned GEMINI canister launch, late 1966 or 1967; manned GEMINI canister launch, 1968; rendezvous and ferry capability possible.

MARINER (NASA)

Jet Propulsion Laboratory, prime. DESCRIPTION: 570-lb. unmanned spacecraft for early interplanetary missions to vicinity of Mars and Venus; boosted by ATLAS-AGENA. STATUS: First scheduled Venus fly-by, August, 1962, unsuccessful after booster failure; second passed within 21,594 mi. of Venus, Dec. 14; two Mars fly-by spacecraft launched in November, 1964; first on Nov. 5 failed due to shroud malfunction; MARINER IV launched Nov. 28, flew by Mars July 14, 1965, and transmitted the first close up photos of the planet; because of press of maintaining APOLLO schedules, NASA has dropped plans for 1966 Mars shot; agency will go directly to VOYAGER, a 7,000-11,000 lb. spacecraft for missions in 1970's.

MILITARY COMMUNICATIONS SATELLITE (Prog. 369) (AF,DCA,Army)

Aerospace Corp., systems engineering & technical direction; Philco, prime. DESCRIPTION: Multiple-launch, random, active repeater comsat; 24 satellites launched in groups of 8 satellites in 18,300-n.mi. polar orbits; weight about 100 lbs.; TITAN III-C booster. STATUS: Full-scale development as an "interim" system which is to be in operation in 1966. DCA has requested ideas from industry on a longer-lived Advanced Communication Satellite system; FY 1968 operational status planned.

NATIONAL ORBITING SPACE STATION (NASA, AF)

Many studies awarded. DESCRIPTION: Manned space station with orbital lifetime of one to five years for testing components and techniques in the space environment; weight ranges under study vary from 15,000-20,000 up to 200,000 lbs. STATUS: Decision not expected for two to four years. MANNED ORBITING RESEARCH LABORATORY and LARGE ORBITING RESEARCH LABORATORY being considered.

NIMBUS (NASA)

Goddard Space Flight Center, prime; GE, integration and testing; RCA, vidicon cameras. DESCRIPTION: 900-1,100-lb. second-generation weather satellite; Earth-stabilized polar orbiting; TV cameras and IR scanners in payload; THRUST-AUGMENTED THOR-AGENA B booster. STATUS: First launching successful Aug. 28, 1964; picture & IR quality good in spite of satellite's elliptical orbit; satellite quit transmitting Sept. 23; second scheduled in 1966, third in 1967 and fourth in 1968-69.

NUCLEAR DETECTION SATELLITES (Formerly Vela) (ARPA)

TRW Systems Group, prime; Los Alamos Scientific Lab/Aerospace Corp., payload. DESCRIPTION: 20-sided, 485-lb. satellite for detection of nuclear explosions in space; 50,000-mi. orbit; booster, ATLAS-AGENA; launched in pairs. STATUS: First pair successfully launched in October, 1963; second pair successfully launched July 17, 1964; three pairs remain.

ORBITAL VEHICLE (AF)

Series of vehicles under OAR project to orbit small scientific experiments at low cost; first two satellites, OV1-1 and -3, both failed, first due to separation mechanism in flight and second due to launch vehicle explosion; first flight was first known attempt to launch satellite from an ATLAS-ABRES vehicle on ballistic trajectory; OV2-1, developed by Northrop, also fell victim to faulty Titan III-C Transtage Oct. 15; Space General at work on OV3.

ORBITING ASTRONOMICAL OBSERVATORY (NASA)

Grumman, prime; Westinghouse, ground station, components; GE, stabilization and control; Kollsman, star trackers; IBM, data processor and storage; Hughes and Avco, communications equipment. DESCRIPTION: 3,600-lb. orbiting astronomical satellite to study ultraviolet spectrum from approximately 1,200 Å to 4,000 Å; four major experiments selected; one piggyback; booster, ATLAS-AGENA D. STATUS: Three flights beginning in early 1966.

ORBITING GEOPHYSICAL OBSERVATORY (NASA)

TRW Systems Group, prime; DESCRIPTION: 1,000-lb. satellite with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; can carry more than 20 experiments; ATLAS-AGENA THRUST-AUGMENTED THOR, booster. STATUS: First launch Sept. 4, 1964, partially successful; 16 of 20 experiments working; OGO II launched Oct. 14, 1965 ceased operation Oct. 24, when electrical power failed.

ORBITING SOLAR OBSERVATORY (NASA)

Ball Brothers, prime. DESCRIPTION: OSO I 458-lb. orbiting solar observatory; OSO II, 535-lbs.; booster, DELTA; S-16 early version; S-17 and S-57 advanced versions. STATUS: First flight March 7, 1962, highly successful; second flight, Feb. 27, 1965, successful. Third satellite, launched Aug. 25, failed to achieve orbit because of premature third-stage ignition, six more flights planned.

PEGASUS (NASA)

Fairchild Hiller, prime. DESCRIPTION: 3,400-lb. meteoroid-detection satellite employing two 50 x 15 ft. extendable detector wings; Earth orbit 300 to 800 mi.; booster, SATURN I. STATUS: Development; will measure size, energy and frequency of meteoroids to evaluate hazards of impact with manned spacecraft; first launch successful in February; PEGASUS B, May 25, 1965, and PEGASUS C, July 30, 1965, also successful. No more launches planned; formerly known as METEORIOD DETECTION SATELLITE.

PIONEER (NASA)

TRW Systems Group. DESCRIPTION: 130-lb. spin-stabilized solar probe; AUGMENTED DELTA launch vehicle; cylindrical; covered with 10,000 solar cells; four outrigger booms for stabilization; five experiments, 60 to 90-million-mi. communication capability. STATUS: Seven launches in program; late-1965 launch schedule set; orbits range from 0.8 to 1.2 au for 6-mo. lifetime; EXTENDED PIONEER under study.

PROJECT SCANNER (NASA)

Honeywell, fabrication and integration; Baird-Atomic, star-mapper telescope; Santa Barbara Research Center, dual radiometers. DESCRIPTION: Unmanned scientific satellite to measure natural radiation gradients of Earth's horizon to determine utility of spacecraft horizon sensors. STATUS: Flights to begin in 1966.

RADIO ASTRONOMY EXPLORER (NASA)

Goddard, prime for first two spacecraft with industry to build remaining four. DESCRIPTION: 270-lb. satellite which will have four 750-ft. extendable antennas to pinpoint radio emissions in space. STATUS: Hardware funding approved in FY '65 & '66 budgets, with first launch by a THRUST-AUGMENTED DELTA in 1967.

RANGER (NASA)

JPL, prime; Hercules, retro-rocket; Northrop, support contractor; RCA, TV system. DESCRIPTION: Before impact, TV cameras take pictures of lunar surface; ATLAS-AGENA B booster. STATUS: RANGER VI launched Jan. 30, 1964, TV system failed; RANGER VII launched July 28, 1964, and impacted Moon after transmitting 4,316 pictures; RANGER VIII launched Feb. 17, 1965, impacted Moon Feb. 20, after transmitting more than 7,000 pictures; RANGER IX launched March 21; struck Moon March 24 after transmitting 5,814 photos; program now complete.

SAMOS (Air Force Program 720A)

Lockheed, prime; photo intelligence equipment, Eastman Kodak; capsules, GE; parachute and guidance recovery equipment, Avco and Northrop Ventura. DESCRIPTION: Reconnaissance satellite; formerly SENTRY; R&D model weighs 4,100 lbs. with E-5 capsule (3,000 lbs. with E-6); booster, ATLAS-AGENA; 100-300-mi. circular polar orbit. STATUS: Operational; advanced SAMOS under development; a successor system, capable of changing orbital plane and altitude on command, is apparently being developed; this newer reconnaissance satellite would have up to six recoverable data capsules or cassettes with lifting-body characteristics, permitting data recovery without returning entire satellite to Earth; could be launched by the TITAN III-B booster now under development; FERRET version used for electronic intelligence and communications eavesdropping.

SATAR (Air Force)

General Dynamics, prime. DESCRIPTION: 300-lb. scientific satellite pod mounted on side of ATLAS booster; length, 55 in.; diameter 27 in.; 200-lb. payload; orbits vary from 500 to 2,000 n. mi.; as re-entry vehicle, gains speeds up to 30,000 fps; guidance, strap-down system with three orthogonally mounted gyros; unstabilized when in orbit. STATUS: Development; seven vehicles being built under present contract; pods of SATAR type have been flown on 44 missions.

SATELLITE INSPECTOR (Air Force PROGRAM 706)

No contractors announced. DESCRIPTION: Satellite inspection system consisting of a spacecraft capable of co-orbital inspection of non-cooperative satellites. STATUS: Re-oriented from unmanned vehicle to manned satellite using GEMINI; conceptual studies under way.

SECOR (Army)

Cubic Corp., prime, transponder and ground stations; ITT Labs, satellite vehicle. DESCRIPTION: 40-lb. geodetic satellite; rectilinear, measuring 9 x 11 x 14 in.; can be carried piggyback on a variety of boosters; frequency, 162-324 mc for geodetic measurements; 54-216 mc for refraction studies. STATUS: Operational SECOR vehicles 1, 3, 2, 4 and 5 now in orbit, launched in order of mention. SECOR 5, launched Aug 10, 1965, is the only non-rectilinear satellite in the series, being a 20-in. polished sphere; future SECORs will be rectilinear; expanded program at altitudes of 1,800 mi. is being considered.

SERT (NASA)

RCA, prime. DESCRIPTION: Spinning ballistic test vehicle carrying two electric-propulsion engines for environmental tests. STATUS: First flight July 20, 1964, from Wallops Island, Va., carried a Lewis electron bombardment engine and a Hughes contact ionization engine; the Lewis engine worked well while Hughes engine produced no thrust: follow-on flights cancelled since SERT I proved neutralization of an ion-beam in space; SERT III now under study.

START (Air Force)

Award in only one of an expected 10-14 areas has been announced; Martin Co. for work on a vehicle related to the in-house SLV-5; Aerospace Corp., general systems engineering and technical direction. DESCRIPTION: A four-part experimental program, beginning with ASSET, to explore the materials, structures, flight regimes and other areas related to glide atmospheric entry. STATUS: Follow-on phases include PRIME, PILOT, and a high L/D ratio vehicle.

SURVEILLANCE CALIBRATION (Navy)

NRL designed and developed satellites for calibrating ground-based systems; 12 satellites launched to date; Latest Aug. 13; five satellites launched aboard single THOR ABLESTAR to check performance of Navy space surveillance system.

SURVEYOR (NASA)

Hughes, prime; Martin, SNAP device. DESCRIPTION: 2,150-lb. spacecraft for soft-landing 100-300 lbs. of instruments on Moon; nine 2,500-lb. spacecraft are also planned; booster, ATLAS-CENTAUR; SNAP nuclear generator optional. STATUS: First Moon flights early 1966; five soft-landing vehicles planned in Block I series; 17 flights scheduled.

SYNCOM (NASA)

Hughes, prime. DESCRIPTION: 24-hr.-orbit instantaneous narrow-band, active-repeater communications satellite; 28 in. in dia. and weighs about 63 lbs.; booster, DELTA; capable of accommodating one full duplex radio telephone channel. STATUS: First launch failed, Feb. 14, 1963; satellite believed to be in orbit but contact lost; SYNCOM II launched July 26, 1963, completely successful; third launch Aug. 19, 1964, successful; satellite, positioned in stationary orbit over Pacific; DOD has taken over satellites for military traffic.

SMS (Synchronous Meteorological Satellite) (NASA)

Republic, RCA Astro-Electronics, Hughes, study contracts. DESCRIPTION: 24-hr. weather satellite, Earth-stabilized; TV cameras with variable focus; may use SNAP-50 for power; booster may be ATLAS-AGENA or -CENTAUR. STATUS: Studies to continue; development funds not included in FY '66 budget; ATS and TIROS expected to provide major inputs to the program.

TIROS (NASA, Weather Bureau)

RCA, prime. DESCRIPTION: 285-lb. meteorological satellite; TV pictures of cloud cover; IR sensors to gather heat balance data; one TIROS to be tested for effectiveness in highly elliptical orbit (300-3,000 mi.). STATUS: R&D; ten satellites launched; all successful; four more launches planned with TIROS wheel configuration (Earth-stabilized) to serve as an interim National Operational System.

TRANSIT (NAVY)

Applied Physics Laboratory, prime; Martin, SNAP device; Westinghouse, shipboard satellite signal receivers. DESCRIPTION: Navigational satellite; R&D model over 250 lbs.; operational, 50 to 100 lbs.; operational system; four satellites in random, near-circular 600-mi. orbits; SNAP nuclear generator; ABLESTAR, SCOUT boosters. STATUS: Four-satellite system operational since July, 1964; system established for use by POLARIS subs and surface ships; two nuclear-powered (SNAP-9A) satellites launched in 1963; NASA studying commercial system.

TRS (Air Force)

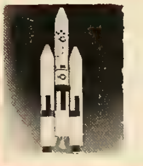
TRW Systems Group. DESCRIPTION: 3-lb. scientific satellite to measure radiation; four-sided, measuring 9 in. on a side. STATUS: Operational; first launched piggyback on DOD payload Oct. 17, 1963.

VOYAGER (NASA)

Either Boeing, GE, or TRW Systems Group will be selected for spacecraft program definition late this year or early next year; DESCRIPTION: Unmanned 7,000-11,000-lb. MARINER follow-on spacecraft bus/lander to orbit Mars and eject a capsule to the surface. STATUS: Development expected to begin in early 1966; lander design to be studied for ten months; program definition funded in FY '66; launches in 1971-73 period; spacecraft to be launched by SATURN V, and will be used to explore other planets through 1970's.

X-15 (NASA, AF, NAVY)

North American, prime; Thiokol, propulsion; Sperry Gyroscope, inertial flight data system; Honeywell, adaptive flight control electronics. DESCRIPTION: Manned rocket plane capable of 4,000-mph-plus flight at edge of space; single rocket engine develops 57,000 lbs. thrust. STATUS: Powered flights in progress; unofficial records set—altitude 354,200 ft. and speed 4,104 mph; hypersonic propulsion research program should run through 1968; more than 100 flights have been made; ramjet (X-15A2) flights scheduled for 1968.



space vehicles

ABLESTAR (Air Force)

Space-General, prime; Aerojet, propulsion; Space-General/Bell Telephone, guidance. DESCRIPTION: 2,000-lb. upper stage; 9.5 ft. long; 55 in. dia.; radio command guidance; propellants, UDMH/IRFNA; restart capability. STATUS: Used in TRANSIT and other military programs; THOR booster.

ATLAS-AGENA D (Air Force)

General Dynamics/Convair (ATLAS); Lockheed (AGENA); TRW/STL, AGENA B; Honeywell, inertial reference. DESCRIPTION: 275,000-lb. booster; payload capability, 5,000 lbs., in 345-mi. orbit, 750 lbs. to escape, length, 102 ft.; base diameter, 10 ft.; liquid propulsion; modified ATLAS D with 360,000-lb. thrust; AGENA B with 15,000-lb. thrust; restart capability. STATUS: Operational; used in RANGER, DISCOVERER, MILITARY COMSAT, MARINER, LUNAR ORBITER, OAO, SAMOS and other programs. ATLAS Standard Launch

Vehicle developed for AF space programs; ATLAS launches from WTR being used in conjunction with ATHENA launches at Green River, Utah, in an effort to develop scaling laws for re-entry bodies (Advanced Ballistic Re-entry Systems program).

AGENA D (Air Force)

Lockheed, prime; Honeywell, guidance; Bell, propulsion. DESCRIPTION: 1,700-lb. upper stage; 25 ft. long; 5 ft. dia.; all-inertial guidance; propellants, UDMH/IRFNA; multiple re-start capability; ATLAS, THOR and AUGMENTED THOR boosters. STATUS: Used in DISCOVERER, SAMOS and other military programs as well as a variety of NASA programs; e.g., MARINER, RANGER, OAO and OGO.

CENTAUR (NASA)

Lewis, program management; General Dynamics/Convair, prime; Pratt & Whitney, propulsion; Honeywell, guidance. DESCRIPTION: High-energy upper stage using a pair of RL-10 LOX/liquid hydrogen engines; 30,000 lbs. total thrust; 30 ft. long; 10 ft. dia.; ATLAS D booster; capable of orbiting 8,500 lbs.; 2,300 lbs. to escape; 1,300 lbs. on planetary flights. STATUS: Development; first flight failed; second launch Nov. 27, 1963, successful; third, June 20, 1964, partially successful; fourth flight Dec. 11, 1964, successful; fifth flight Mar. 2 failed when ATLAS-CENTAUR exploded on pad; CENTAUR 6, Aug. 11, 1965, successful; CENTAUR 7 flight early next year.

DELTA (NASA)

Douglas, prime; Bell Telephone Labs, guidance; Rocketdyne/Aerojet/Allegany Ballistics Laboratory, propulsion. DESCRIPTION: Successor to THOR-ABLE; upper-stage guidance; three-stage vehicle; 800-lb. payload capability in 100-mi. orbit; THRUST-AUGMENTED DELTA payload capability 1,500-plus lbs. in 100-mi. orbit; THOR missile comprises first stage. STATUS: Launch vehicle for TIROS, EXPLORER, OSO, BIOS, ECHO; TAD used for SYNCOM & PIONEER; 26 previously on order augmented by AF order for 21 more for NASA; THRUST-AUGMENTED DELTA with three solid motor strap-ons also being used.

LITTLE JOE II (NASA)

General Dynamics/Convair, prime. DESCRIPTION: Solid-propelled vehicle with 800,000-lb. thrust; launch vehicles for APOLLO suborbital flights. STATUS: Three launches: Aug. 28, 1963; May 13, 1964; Dec. 8, 1964, successful; May 19, 1965, launch unsuccessful; June 29, 1965 launch successful; six vehicles ordered thus far.

POST-SATURN V LAUNCH VEHICLE (NASA)

Under study. DESCRIPTION: No firm concept but will be significant improvement over SATURN V (20-30 million-lb.-thrust first-stage large solid motors, and nuclear upper stage under consideration). STATUS: Study to determine characteristics; operational target date post-1975.

ROVER (NASA, AEC)

Los Alamos Scientific Labs, ROVER prime; Aerojet, NERVA prime; Westinghouse, propulsion. DESCRIPTION: First nuclear rocket; tests of Kiwi, prototype of NERVA engine, under way. STATUS: Kiwi tests completed this year; NERVA tests highly successful; full systems tests of engine now set for fall, 1965—12 months ahead of schedule; development of Phoebus reactor initiated; no flight test program funded at present.

SATURN I (NASA)

Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler Corp.; S-IV, Douglas. DESCRIPTION: Two-stage vehicle for early boilerplate tests of APOLLO and PEGASUS; first stage: eight Rocketdyne H-1 engines; second stage: six Pratt & Whitney RL-10-A3 engines; 22,500 lbs. into 345-mi. orbit. STATUS: Four flight tests of first stage successful; all flights with inert upper stage; first flight with live upper stage successfully launched Jan. 27, putting 37,700 lbs. in low Earth orbit; SA-6 May 28, 1964 and SA-7 Sept. 18, 1964, also successful; SA-9 on Feb. 16 put PEGASUS satellite into orbit; SA-8, May 25, and SA-10, July 30, 1965, also successful, completing R&D program.

SATURN IB (NASA)

Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler; S-IVB stage, Douglas. DESCRIPTION: S-1, eight H-1 engines; S-IVB, one J-2 engine; payload capability, 35,000 lbs. in 105-mi. orbit. STATUS: Development; first flight in 1966; boost APOLLO spacecraft boilerplate models, including lunar landing vehicle; first manned flight in APOLLO program set for October, 1966; advanced version able to orbit 30 tons under consideration.

SATURN V (NASA)

Systems engineering, assembly and guidance, Marshall Space Flight Center; S-IC stage, Boeing; S-II, North American; S-IVB, Douglas; F-1 engine, North American; J-2, North American. DESCRIPTION: S-IC, five F-1 engines; S-11, five J-2 engines; S-IVB, J2 engine; 140-ton payload in 105-mi. orbit; 95,000 lbs. to escape velocity; 30 tons for planetary missions. STATUS: R&D; first flight scheduled for 1967; prime booster for APOLLO missions; will be used to boost orbiting space station.

SCOUT (NASA)

LTV Aerospace Corp., prime; Honeywell, guidance; Aerojet/Thiokol/Allegany Ballistic Laboratory, propulsion. DESCRIPTION: Solid propulsion four-stage satellite launcher; 72 ft. long; 3.3 ft. dia.; 240-lb. payload in 345-mi. orbit; 80 lbs. to escape. STATUS: Operational; used by NASA for EXPLORER and other small payloads; also procured by NASA for Air Force as BLUE SCOUT.

THOR-ABLESTAR (Air Force)

Douglas, prime; Bell Telephone Labs, guidance; Rocketdyne, first-stage propulsion; Space-General, second; DESCRIPTION: Two-stage vehicle with 181,900 lbs. total thrust; performance, 900 lbs. in 100-n.-mi. orbit; length, 55.9 ft., diameter, 8 ft., weight, 118,200 lbs., height, 79 ft.; guidance, radio command; STATUS: Operational; used in TRANSIT, GEOS and other military programs.

THOR-AGENA D (Air Force and NASA)

No prime; Douglas, THOR frame; Lockheed, AGENA D; Rocketdyne, propulsion. DESCRIPTION: Liquid-propulsion vehicle to put 1,600-lb. payload in 300-mi. orbit; length, 76 ft.; diameter, 8 ft.; launch weight, 123,000 lbs.; 172,000 lbs. thrust; THOR, radio guidance, AGENA, all-inertial. STATUS: Operational; used in AF space program, TELSTAR, Topside Sounder and other NASA programs; NASA has 11 launches scheduled.

THRUST-AUGMENTED DELTA (NASA)

Douglas, prime; Thiokol, solid propulsion. DESCRIPTION: DELTA launch vehicle with three strap-on solids; performance, 1,000 lbs. to Earth orbit; 150 lbs. to escape; propulsion, three XM-33 solid motors producing 55,000 lbs. thrust each. STATUS: Development; to be used for BIOSATELLITE, PIONEER, SYNCOM, TIROS, COMSAT programs; initial flight Aug. 19, 1964, successful.

THRUST-AUGMENTED THOR (Air Force/NASA)

No prime; Rocketdyne and Thiokol, propulsion. DESCRIPTION: THOR-AGENA with 3 strap-on solids; THOR liquid propulsion, 172,000 lbs. of thrust; each strap-on, 55,000 lbs. thrust; performance, 2,500 lbs. in 100-n.mi. orbit. STATUS: Operational; used for NIMBUS, POGO and other payloads too heavy for THOR, but not heavy enough for ATLAS.

TITAN II (GLV) (NASA)

Aerospace Corp., systems engineering & technical direction; Martin, prime. DESCRIPTION: Manned space booster; Essentially TITAN II with addition of redundant electrical power and flight control systems, malfunction detection system and radio command guidance. STATUS: Development; GT-2 (unmanned version) launched Jan. 19; GT-3 successful on March 23; GT-4, June 3, and GT-5, Aug 21, also successful.

TITAN III (Air Force Program 624A)

Aerospace Corp., systems engineering & technical direction; Martin, systems integration; United Technology, large solid boosters; Martin, TITAN II portion; Aerojet-General, liquid engines (Transtage); Martin, standardized upper stage; AC Spark Plug, guidance. DESCRIPTION: Quick-reaction vehicle for military space missions; will be used to boost MOL/GEMINI X; Zero stage, two 120-in. solid motors; first and second stages, TITAN II (storable propellants); third-stage is liquid Transtage; modified TITAN II guidance; payload, 25,000 lbs. in 100-n.mi. orbit, 2,100 lbs. to 22,300-mi. orbit; 5,000 lbs. to escape; STATUS: Development; first flight Sept. 1, 1964 (T-IIIA) achieved primary and secondary objectives, but failed to achieve orbit; second flight (T-IIIA) successful Dec. 10, 1964; first full TITAN III-C flight successful June 18, 1965; second flight Oct. 15, successful launch followed by partial Transtage failure; 16 or 17 development flights planned; four TITAN II core vehicles (A version), 12 or 13 full TITAN III's (C version); eight or more other satellite payloads have been approved for launch during flight test program; development stretchout moves operational date to June, 1967; a non-man-rated version—TITAN III-B—being studied as more cost/effective booster for satellite launches; uses first two TITAN III-A stages and an AGENA upper stage; first launch, mid-1966; 24 vehicles planned as initial buy; 7-segment version of III-C expected to boost MOL.

missiles

ADVANCED SURFACE MISSILE SYSTEM (Navy)

Raytheon, Boeing, Sperry Rand, General Electric, Westinghouse, RCA & Hughes, pre-program definition contracts. DESCRIPTION: Fleet air-defense weapon for the 1970 time period; to have capability against aircraft and certain types of air-to-surface missiles; will replace the 3-T systems currently in the fleet. STATUS: Pre-program definition; further definition contracts expected before any development decision; commonality with Army's SAM-D has been studied; program still faces uncertainties.

ALFA (RUR-4) (Navy)
Navy, prime; Avco, frame; Naval Propellant Plant, propulsion. DESCRIPTION: ASW, surface-to-underwater; weight, 500 lbs.; solid propulsion; H.E. depth charge; range, 1,000 yds.; guidance, free-flight. STATUS: Operational; deployed on destroyers and cruisers; being replaced by ASROC.

ANTI-SATELLITE WEAPON (Army/Air Force)
Boeing, AF program; Hughes, terminal guidance (IR), AF program; Douglas, THOR and ZEUS vehicles and support services; A. D. Little, operations analysis. DESCRIPTION: Consists of both NIKE-ZEUS and THOR-AGENA w/terminal stage programs; intercepts have been accomplished at "hundreds of miles," according to Secretary McNamara. STATUS: Operational according to DOD; however, major portions of the AF program are uncompleted at the Johnston Island test site.

ARM I (Navy)
No contractor announced. DESCRIPTION: Longer-range, smaller anti-radiation missile than SHRIKE for armament of F-111B and A-7A aircraft. STATUS: Advanced component development; decision on contract definition expected next year.

ASROC (RUR-5A) (Navy)
Honeywell, prime; Sangamo Electric, sonar; GE, torpedo; Librascope-General Precision, fire control. DESCRIPTION: ASW, surface-to-underwater; weight, 1,000 lbs.; solid propulsion; warhead, nuclear or conventional torpedo; range between 1,800 yds. and 8 mi.; guidance, unguided. STATUS: Operational on DE, DD, DLG, & heavy cruisers; one "live" weapon fired in 1962 Pacific nuclear tests; extended-range version in pre-program definition phase; version adaptable to TERRIER launchers being developed; FY 1966 procurement to complete Navy's stock needs.

BOMARC A (AIM-10A) (Air Force)
Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion. DESCRIPTION: Surface-to-air interceptor; weight, 15,000 lbs.; liquid booster/ramjet propulsion; warhead, nuclear; range, 200 n.mi.; guidance, command via SAGE; speed, Mach 2.5; ceiling, over 68,000 ft. STATUS: All A missiles at five bases operational in northeastern U.S. phased out by the end of FY 1965; production completed; costs $20 million per year to operate system.

BOMARC B (AIM-10B) (Air Force)
Boeing, prime; General Precision Aerospace/Westinghouse/IBM, guidance; Thiokol/Marquardt, propulsion. DESCRIPTION: Surface-to-air; weight, 16,000 lbs.; solid booster/ramjet propulsion; warhead, nuclear; range, more than 400 n.mi.; guidance, command via SAGE; speed, Mach 2.7. STATUS: Three bases operational; production completed; the 188 B models will be distributed among the eight bases after the A model is phased out.

BULLPUP (AGM-12 B & C) (Navy-Air Force)
Martin, systems cognizance; Maxson Electronics Co., production; Thiokol, liquid and solid propulsion; Naval Propellant Plant, solid propulsion (motor loading). DESCRIPTION: Air-to-surface, range, 3-6 mi.; guidance (visual reference), radio-link command. BULLPUP A: Solid propulsion; warhead, 250-lb. H.E. BULLPUP B&C: pre-packaged liquid motor; warhead, 750-lb. H.E. STATUS: BULLPUP A deployed with Atlantic and Pacific Fleets; operational with U.S. Air Force & NATO units; training version (ATM-12) being procured by both services; being produced in Europe for NATO. Planned procurement of BULLPUP B cancelled in FY 1966.

CHAPARRAL (Army)
A surface-to-air adaptation of the Navy's air-to-air SIDEWINDER. Mounted on vehicles, in a 4- or 6-missile configuration. Philco's Aeronutronic Div. is prime; CHAPARRAL will be an interim, fair-weather-only, solution to forward-area air defense; has been successfully fired, production award expected soon. (See: SIDEWINDER.)

CLOSE-SUPPORT ASSAULT WEAPON (Navy)
Navy Bureau of Weapons and Johns Hopkins Applied Physics Lab, prime; United Aircraft Norden Div., guidance. DESCRIPTION: Ship-to-shore; outside dimensions compatible with TERRIER shipboard installations; solid propulsion; warhead, H.E.; range, 30 mi. minimum; guidance, inertial and terminal. STATUS: Carried as a line item in FY '66 budget; gyro packages for flight test delivered by Norden; funding dependent on results of guidance system flight tests at WSMR aboard SERGEANT missiles in July.

CONDOR (AGM-53) (Navy)
In-house project, Naval Ordnance Test Station; North American Aviation, Columbus Div. and Northrop Norair Div. completed PDP studies. DESCRIPTION: Air-to-surface TV-guided, stand-off weapon; configuration classified; range, 40 mi. STATUS: Development; intended for use with Navy version of F-111 and on A-6 aircraft; decision on development expected in next few months.

DAVY CROCKETT (M-388) (Army)
In-house project directed by Army Weapons Command at Rock Island, Ill. DESCRIPTION: Surface-to-surface; solid propulsion, bazooka-launched; warhead, sub-kiloton nuclear; guidance, free flight; two launchers — vehicle-mounted or carried by two men. STATUS: Operational in Europe; $13 million provided in FY '64 budget; three per ROAD battalion.

ENTAC (MGM-32) (Army)
Nord Aviation, prime. DESCRIPTION: Anti-tank; weight, 37 lbs. with launcher; solid propulsion; warhead, shaped-charge H.E.; range, 6,600 ft.; guidance, wire-guided; man-portable. STATUS: Operational; procurement complete; will be replaced by TOW.

FALCON (AIM-4A, C, E, F/26A/47A) (Air Force)
Hughes, prime; Hughes, guidance; Thiokol, AIM-4/26 propulsion; Lockheed Propulsion, AIM-47 propulsion. DESCRIPTION: Air-to-air; weight (AIM-4/47), more than 100 lbs. — (AIM-26), more than 200 lbs.; range 5 n.mi.; supersonic; solid propulsion; warhead, H.E. (except for AIM-26B, which carries nuclear warhead); AIM-4A, and 4E, active radar homing guidance; AIM-4C, and 4F, IR homing; AIM-26 model has nuclear warhead and hybrid IR radar homing. STATUS: Operational buy-out of 4E, 4F and 26 in FY '62; AIM-47 is the armament for YF-12A (A-11); several versions operational on F-101, F-102 and F-106.

GENIE (AIR-2A) (Air Force)
Douglas, prime; Aerojet-General, propulsion. DESCRIPTION: Air-to-air; weight 800 lbs.; unguided; solid propulsion; warhead, nuclear; range, 6 n.mi.; guidance, free flight; supersonic; proximity fuzing. STATUS: Procurement complete; operational on F-101B and F-106; improved version cancelled. Launcher being developed by McDonnell for adaptation to F-4 aircraft.

HAWK (MIM-23A) (Army)
Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion. DESCRIPTION: Surface-to-air; weight, 1,275 lbs.; solid propulsion; warhead, H.E.; range, 22 mi.; guidance, semi-active radar homing; 100-45,000-ft. ceiling; provides defense against medium and low-flying aircraft and cruise-type missiles. STATUS: Operational, deployed in Europe, Panama, Okinawa, South Viet Nam, U.S. (13 battalions); bought by Sweden and Israel; R&D being conducted to adapt selected HAWK units to an anti-tactical ballistic missile; NATO producing; Japan also plans buy; $34 million requested for equipment and $8 million for spares in FY '66; no further procurement in FY '66; $11 million improvement program aimed at limited anti-missile capability.

HIBEX (ARPA/Army)
Boeing, prime; Hercules and Aerojet, propulsion. DESCRIPTION: Experimental program in high-energy propellants; cone-shaped missile; performance classified; solid propulsion. STATUS: Development; accelerations of 800 to 1,000 g's goal; static test of motor successful, Nov. 1964; flight test program of 10 vehicles being conducted at WSMR; second successful flight test, May '65, at WSMR.

HONEST JOHN (MGR-1) (Army)
Douglas/Emerson Electric, prime; Hercules, propulsion. DESCRIPTION: Surface-to-surface; weight, 5,900 lbs.; single-stage solid propulsion; warhead, nuclear; range, 12 mi. (M-31), 20 mi. (M-50); unguided. STATUS: Operational; M-50 being deployed in Europe; to be replaced by LANCE; procurement complete.

HORNET (ZAGM-64A) (Air Force)
(Formerly known as ATGAR). Concept based on North American Aviation Columbus Div. unsolicited proposal, funded by AF. DESCRIPTION: Air-launched, anti-tank weapon, electro-optical guidance. STATUS: pre-development, AF procuring missiles for test at Eglin AFB; Army interested in potential use on helicopters; larger version, known as MAVERICK, also in pre-contract definition; both part of AF SOR-215 series.

HOUND DOG (AGM-28) (Air Force)
North American, prime; Autonetics, guidance; Pratt & Whitney, propulsion. DESCRIPTION: Air-breathing air-to-surface standoff missile; weight, 9,600 lbs.; turbojet propulsion; warhead, nuclear; range, about 600 n.mi.; guidance, all-inertial; ceiling in excess of 50,000 ft.; Mach 2+. STATUS: Operational; to be launched from B-52G intercontinental bombers; procurement complete.

LANCE (XMGM-52) (Army)
LTV Aerospace, prime; Systron-Donner, guidance. DESCRIPTION: Highly mobile general-purpose missile; very light weight; pre-packaged storable liquid propellant; warhead, nuclear and H.E.; range, 3-30 mi.; guidance, Automet inertial, one missile per launcher. STATUS: Large-scale development. Tenth flight test, Oct. 10, '65, from operational launcher; production decision depends on success of current flight tests; eventually will replace HONEST JOHN and LACROSSE and perhaps LITTLE JOHN; division support weapon; to use multi-system test equipment; Navy also studying shipboard version.

LITTLE JOHN (MGR-3) (Army)

Emerson Electric, prime; Hercules Powder, propulsion. DESCRIPTION: Surface-to-surface; weight, 800 lbs.; solid propulsion; warhead, nuclear; range, 10 mi.; unguided; supplements medium and heavy artillery in airborne divisions and air-transportable commands. STATUS: Two battalions activated in 1961; each equipped with four launchers; air- and helicopter-transportable; may be replaced by LANCE.

MACE (MGM-13A, CGM-13B) (Air Force)

Martin, prime; Goodyear/AC Spark Plug, guidance, Thiokol/Allison, propulsion. DESCRIPTION: Air-breathing surface-to-surface; weight, 18,000 lbs.; turbojet and solid propulsion; warhead, nuclear and H.E.; range, over 650 n.mi. (Model A), over 1,200 n.mi. (Model B); guidance, map-matching (A), Inertial (B). STATUS: Five MACE-A and one MACE-B squadrons (in hard sites) deployed in Europe; two MACE-B squadrons on Okinawa in hard sites.

MAW (Army)

McDonnell Aircraft Corp. and Army Missile Command, development of competitive approaches to Medium Anti-Tank/Assault Weapon requirement; Ford Instrument Co., gyro package for Army version. DESCRIPTION: Surface-to-surface; solid propellant; range, 500-1,500 yds.; shoulder-fired; McDonnell version wire-guided; Army version two-degree-of-freedom, free rotor gyro. STATUS: Exploratory development; competitive approaches have been fired against each other, using a ZUNI test vehicle; the best system will be allowed to proceed into full-scale development when evaluation is complete; MAC version completed test series with all 13 firings successful.

MINUTEMAN (LGM-30) (Air Force)

TRW Systems Group, systems engineering and technical direction; Boeing, major contractor; Autonetics, guidance, Thiokol, first-stage propulsion; Aerojet, second-stage propulsion; Hercules, third-stage propulsion; Avco, re-entry vehicle; GE, MARK 12 re-entry vehicle, MINUTEMAN II. DESCRIPTION: 2nd-generation ICBM; weight, over 65,000 lbs.; solid propulsion; warhead, nuclear; 3 stages; range, 7,000 mi.; guidance, all-inertial, target selected in seconds; 32-sec. reaction time. STATUS MINUTEMAN II flight-test program (36 shots planned) began Sept. 24, 1964; 800 MINUTEMAN I's now operational; 1,000 missiles through FY '65; advanced version can be fired by airborne command posts; deployed in hardened and dispersed silos; MINUTEMAN II expected operational 1965; all MINUTEMAN I missiles to be replaced by MINUTEMAN II in phased replacement program costing $1 billion and beginning in 1966; some of the II's replace earlier models; MMII has greater accuracy (nearly 8 times more) and range/payload than I version; 12 successful MINUTEMAN II launches now completed, with most recent launch Oct. 6, 1965; maneuverable re-entry vehicle under development.

NIKE-HERCULES (MIM-14B) (Army)

Western Electric, prime; Western Electric, guidance; Hercules and Thiokol, propulsion; Douglas, airframe. DESCRIPTION: Surface-to-air, antiaircraft, tactical; weight, 10,000 lbs.; solid propulsion; warhead, nuclear or H.E.; range, 75 mi.; guidance, command; Mach 3+; ceiling in excess of 150,000 ft. STATUS: Over 80 batteries deployed in U.S. being turned over to National Guard; over 10 N-H batteries deployed overseas; Japan plans additional procurement; being equipped with HIPAR, a high-power acquisition radar, and antitactical-ballistic-missile capabilities. Re-location of some HERCULES batteries under consideration by JCS.

NIKE-X/Zeus (XLIM-49) (Army)

Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, propulsion; Douglas, airframe. DESCRIPTION: Antimissile missile, 3-stage; weight, 22,800 lbs.; solid propulsion; warhead, nuclear; range, 200-mi.; guidance, command; length, 48 ft.; diameter, 36 in.; fin span, 10 ft. STATUS: Missile is now part of NIKE-X missile "mix"; development, except as part of X, has ended; no intercept "failure" in more than a year of tests; $10 million requested for preliminary production engineering in FY 1966; advanced version of ZEUS (DM15X2) now under development reflects important breakthrough in long-range (400-mi.) ICBM interception.

NIKE-X (Army)

Western Electric, prime; Bell Telephone, guidance; Thiokol, ZEUS propulsion; Douglas, ZEUS airframe; Martin Marietta, SPRINT missile prime; Hercules and Lockheed, SPRINT propulsion. DESCRIPTION: Successor to ZEUS as an anti-ICBM system; uses a mix of ZEUS/SPRINT missiles and multi-function array radar (MAR). STATUS: Engineering development; funded at $400 million in FY '66 on accelerated development schedule, but deployment still deferred; GE will submit proposals on a hardened NIKE-X system. Tests to be conducted late this year with MAR at WSMR, N.M., could provide basis for deployment decision; deployment cost: $8-20 billion; key decision expected late this year.

PERSHING (MGM-31) (Army,

Martin, prime; Bendix, guidance; Sperry Farragut, fuzing and aiming; Thiokol, propulsion. DESCRIPTION: Surface-to-surface; weight, 10,000 lbs.; two-stage solid propulsion; warhead, nuclear; range, approx. 400 n.mi.; guidance, inertial; transported on FMC M474 tracked vehicles; replaced REDSTONE. STATUS: Flight test program completed; troop firings from Ft. Wingate, N.M., to White Sands being conducted; number of missile-loaded launchers per unit to be increased; West Germany organizing two battalions; first U.S. PERSHING battalion deployed to Germany in April, 1964.

PHOENIX (AIM-54) (Navy)

Hughes Aircraft Co., prime; Rocketdyne, propulsion. DESCRIPTION: Air-to-air missile for use with the F-111B fighter aircraft; each aircraft will be able to carry six missiles. Missile control system designated AN/AWG-9; and missile/bomb launcher is MAU-48A. STATUS: Development. First flight test planned in March, 1966. $71 million in FY '66 funds; some development problems.

POLARIS (UGM-27 A, B, C) (Navy)

Lockheed, prime; GE/MIT/Hughes/Honeywell/Raytheon, guidance and fire control; Aerojet-General/Hercules, propulsion; Lockheed, re-entry vehicle; Nortronics, checkout; Autonetics/Sperry, SINS; Westinghouse, launching equipment; Vitro, systems engineering coordination and training; Systron-Donner, ignition programming. DESCRIPTION: Underwater- and surface-to-surface; weight, 30,000 lbs.; solid propulsion; warhead, nuclear; range, 1,200 n.mi. (A-1), 1,500 n.mi. (A-2), 2,500 n.mi. (A-3); guidance, all-inertial. STATUS: 24 subs operational each with 16 A-2 or A-3 missiles; all A-1's now retired; A-3, operational in August, 1964; going on subs 19-41; total of 41 POLARIS subs authorized; deployed in Atlantic and Mediterranean; Pacific deployment began in 1964; British to buy A-3 missiles from U.S. POSEIDON, follow-on FBM, about to go into full-scale development; same contractors as POLARIS except for propulsion; Hercules/Thiokol first stage; Hercules second stage; same range as A-3 with double payload and accuracy; 50-month development effort; may go aboard 19 subs; PenAids and warhead can be field-changed.

QUAIL (ADM-20C) (Air Force)

McDonnell, prime; McDonnell, electronics, guidance; GE, propulsion; TRW, Inc., ECM equipment. DESCRIPTION: ECM-carrying decoy, which simulates B-52 bomber, to enemy radar; turbojet powered; range, 250 mi.; guidance, gyroscopic autopilot. STATUS: Deployed at SAC bases; carried by B-52; procurement completed FY '61; advanced version with 400-mi. range has been flight tested.

REDEYE (MIM-43) (Army)

GD/Pomona, prime; Atlantic Research, propulsion; MPB, Inc., seeker optics. DESCRIPTION: Surface-to-air; weight, 28 lbs.; solid propulsion; warhead conventional; guidance, IR-homing; length 48 in.; diameter, 2.75 in. STATUS: Production; tests against helicopters and jets at NOTS successful.

REGULUS I (RGM-6) (Navy)

LTV Aerospace Corp., prime; Sperry, guidance; Allison, propulsion. DESCRIPTION: Surface-to-surface; weight, 14,000 lbs.; turbojet and solid propulsion; warhead, nuclear; range, 500 n.mi.; guidance, inertial; speed, about 600 mph; ceiling, approx. 40,000 ft. STATUS: Five REGULUS subs with 17 missiles are operational now; 3 subs (8 missiles) phased out in FY '65.

SAM-D (Formerly AADS-70) (Army)

Hughes/Douglas/FMC, RCA/Beech, competitive component development contracts. DESCRIPTION: Field army ballistic missile defense system, mobile. STATUS: Decision on development expected later this year; both RCA and Hughes to get 4-6-month contract-definition-phase awards if program proceeds; Army has named project manager in advance of expected program authorization.

SERGEANT (MGM-29A) (Army)

Sperry Utah, prime; Sperry, guidance; Thiokol, propulsion. DESCRIPTION: Surface-to-surface; weight, 10,000 lbs.; solid propulsion; warhead, nuclear; range, over 75 n.mi.; guidance, inertial; uses drag brakes. STATUS: Operational procurement complete; deployed in Europe; replacement for CORPORAL; West Germany buying system. $1.9 million requested in FY 1966 for warhead adaptation kits.

SHILLELAGH (MGM-51A) (Army)

Philco Aeronutronic; prime, Picatinny Arsenal/Amoco Chemicals Corp., propulsion; Aeronutronic, guidance. DESCRIPTION: Surface-to-surface; lightweight; solid propulsion; warhead, nuclear or H.E.; guidance, command; vehicle-mounted for use against field fortifications, armor and for close-in support of troops. STATUS; Production. Initial procurement in FY '65; second-source procurement may come in FY '66; to use multi-system test equipment; to be installed on Gen. Sheridan assault vehicle; also being considered for use on helicopters; Philco has contract to adapt missile to Army's M-60 tank.

SHRIKE (AGM-45A) (Navy)

Naval Ordnance Test Station-China Lake, prime; Texas Instruments, guidance and control; North American Rocketdyne (McGregor), propulsion. DESCRIPTION: Air-to-surface, anti-radar; solid propulsion; guidance, passive radar homing. STATUS: Operational with Navy and Air Force; some reliability problems; advanced version under development.

SIDEWINDER I-C (AIM-9D) (Navy, Air Force)

Naval Ordnance Test Station, technical direction; Philco, IR guidance, Motorola, radar guidance; Naval Ammunition Depot, McAllister, motor loading; Rocketdyne (McGregor), propellant. DESCRIPTION: Air-to-air; weight, about 155 lbs.; solid propulsion; warhead, H.E.; range, more than 2 mi. STATUS: 1-A deployed with Navy and Air Force; 1-C version being procured as replacement for 1-A; NATO-built version now in production. (See CHAPARRAL).

SPARROW III-6B (AIM-7E) (Navy)

Raytheon, prime; Raytheon, airframe, control, guidance; Aerojet-General/North American Rocketdyne (McGregor), propulsion; McDonnell/Benrus Watch Co., launcher. DESCRIPTION: Air-to-air; weight, 350 lbs.; solid propulsion; warhead, conventional; range, 5-8 mi.; guidance, semi-active CW homing; Mach 2.5-3; ceiling, over 50,000 ft. STATUS: Earlier models operational with carrier aircraft; SPARROW III-6B prime armament for Phantom II (F-4B) and other high-performance interceptors. SEA SPARROW, a shipboard-launched adaptation being considered by Navy as a point-defense weapon for small vessels; would use 3-in. modified gun mount as launcher.

SPRINT (Army)

Martin-Orlando, prime; Hercules Powder/Lockheed Propulsion Co., propulsion; Bell Telephone Laboratories, guidance. DESCRIPTION: High-acceleration cone-shaped missile for low-altitude interception of ballistic missiles; 4.5-ft. base diameter, 27 ft. long; two-stage; nuclear; missile will be popped out of silo before motor is ignited; to be part of the missile mix in a NIKE-X battery. STATUS: Development; first flight in March, 1965, tested vehicle aerodynamically but without gas-generator pop-up procedure; pop-up tests to prove silo ejection concept and mechanism under way at Martin-Orlando plant; first full flight test (number 3), including pop-up, planned in fall of 1965 from silo being completed at WSMR.

SRAM (Air Force)

Four-month CDP contracts expected this month; four firms still in competition. DESCRIPTION: Air-to-surface defense-suppression stand-off missile for use with the B-52, B-58, F-111 or the Advanced Manned Strategic Aircraft. STATUS: AF contracting feasibility tests for LASRM (Low-altitude Supersonic Research Missile), aiming at doubling SRAM's range; Congress cut FY '66 budget request by $30.7 million; development go-ahead not expected until August, 1966.

STANDARDIZED MISSILE (Navy)

No contractors. DESCRIPTION: Fleet air-defense missile to replace TARTAR-TERRIER and give Navy a single missile to perform both missions; longer-range targets (30+ miles) would be engaged by adding a booster to the shorter-range (10+ miles) weapon; similar to the homing TERRIER now being procured. STATUS: Development; expected to be procured initially in 1967-68; intended to work with new TARTAR-D digital fire control.

SUBROC (UUM-44A) (Navy)

Naval Ordnance Laboratory, technical direction; Goodyear, prime; General Precision Aerospace, guidance; Thiokol, propulsion; General Precision Librascope, fire control. DESCRIPTION: Underwater-air-underwater anti-submarine missile depth bomb; solid propulsion; warhead, nuclear; weight, 4,000 lbs.; length, 21 ft.; diameter, 21 in.; range, 25-30 mi.; guidance, inertial. STATUS: Production scheduled for installation in Thresher-class subs; operational evaluation under way.

SS-10 (Army)

Nord Aviation, prime. DESCRIPTION: Surface-to-surface, primarily anti-tank; weight, 33 lbs.; solid propulsion; warhead, conventional; range, 1,600 yards; wire-guided. STATUS: Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. replacing with ENTAC.

SS-11 (Army)

Nord Aviation, prime. DESCRIPTION: Surface-to-surface anti-tank, also helicopter-to-surface; weight, 63 lbs.; solid propulsion; wire-guided; warhead, conventional; range, 3,800 yds. STATUS: Operational, used with airborne units and Army helicopters; AS-12 being considered by Navy for ASW aircraft.

TACTICAL PROBE (Navy)

Bendix, prime: DESCRIPTION: Surface-to-air; multiple, interchangeable payloads for each mission; booster, TERRIER or TALOS from shipboard installations; high-impulse second stage; range, 50-300 mi.; parachute descent. STATUS: Program definition; a new study has been authorized, and is under way, to evolve a cheaper program.

TALOS (RIM-8E) (Navy)

Bendix, prime; Vitro, systems engineering; McDonnell/Hercules Allegany Ballistics Lab., propulsion; Sperry, guidance; GE, launching gear. DESCRIPTION: Ship-to-air; weight, 7,000 lbs.; solid and ramjet propulsion; warhead, nuclear; range, 65 n.mi.; guidance, radar beam riding/semi-active homing; Mach 2.5. STATUS: Operational aboard cruisers Galveston, Little Rock & Oklahoma City and three Albany-class DEG's; Long Beach, nuclear-powered cruiser, has advanced TALOS; "3-T" get-well program increasing reliability; procurement continuing.

TARTAR (RIM-24B) (Navy)

Vitro, systems coordination engineering; Applied Physics Lab, design and development; GD/Pomona, Aerojet-General, propulsion; Sperry Farragut, fuze (target detection device). DESCRIPTION: Ship-to-air; weight, 1,500 lbs.; solid dual-thrust motor; warhead, conventional; range, 10 n.mi.; guidance, semi-active homing; Mach 2. STATUS: Operational; installed aboard 23 guided missile destroyers and three cruisers equipped with TALOS; get-well program progressing satisfactorily; CVA Kennedy will also have TARTAR.

TERRIER (RIM-2E) (Navy)

Vitro, systems engineering; GD/Pomona, prime; GD/Pomona, guidance section; Sperry, radar; Hercules Allegany Ballistics Laboratory, propulsion; Northern Ordnance, launching gear. DESCRIPTION: Ship-to-air; weight, 3,000 lbs.; 27 ft. long; solid propulsion; warhead, conventional; range 10 n.mi.; guidance, radar beam-riding or homing; Mach 2.5. STATUS: Operational aboard two attack carriers, 6 cruisers, and 12 missile frigates; get-well program progressing satisfactorily.

TITAN II (LGM-25C) (Air Force)

Martin, prime; TRW Systems Group, systems engineering and technical direction; AC Spark Plug, guidance; Aerojet-General, propulsion; GE, re-entry vehicle. DESCRIPTION: ICBM; weight, 330,000 lbs.; N_2O_4 and Aerozine-50 storable fuels; warhead, nuclear; range, over 5,000 mi.; guidance, inertial; 115 ft. long; 2 stages; greatest payload and range of any U.S. ICBM, basic core vehicle for TITAN III booster. STATUS: All 54 missiles operational in 18-missile squadrons at Davis-Monthan AFB, McConnell AFB, and Little Rock AFB.

TMRBM (Air Force)

No contractors announced, but probably would be same team producing the second and third stages of MINUTEMAN II. DESCRIPTION: A transportable mid-range missile to fill the gap left by cancellation of MMRBM; it would use the top two stages of MM II and the MM II guidance system; would weigh more and be less mobile than MMRBM, but could be developed for approximately one-third the cost; reaction time also less than MMRBM's; employment concept much the same as that of the Russian-deployed missiles in Cuba in 1962. STATUS: Study by the Air Force at DDR&E direction; not likely to be developed due to a lack of mission.

TOW (Army)

Hughes, prime. DESCRIPTION: Anti-tank; weight, 160 lbs.; solid propulsion; warhead, H.E.; wire-guided; optically tracked; tube-launched. STATUS: Development; follow-on to ENTAC; successful firings have been conducted; helicopter use planned.

WALLEYE (Navy)

NOTS development; TV-guided glide bomb with good stand-off range; production expected soon; smaller version, called SNIPE, under NOTS development for Army helicopters.

ZUNI (Navy)

Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion. DESCRIPTION: air-to-surface; weight, 107 lbs.; solid propulsion; warhead, conventional; range, 5 n.mi.; unguided; STATUS: Operational; designed for use on jet fighter and attack aircraft.

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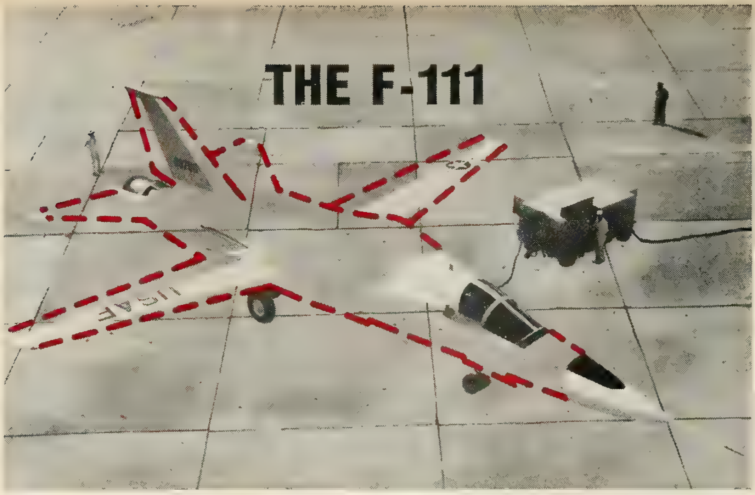
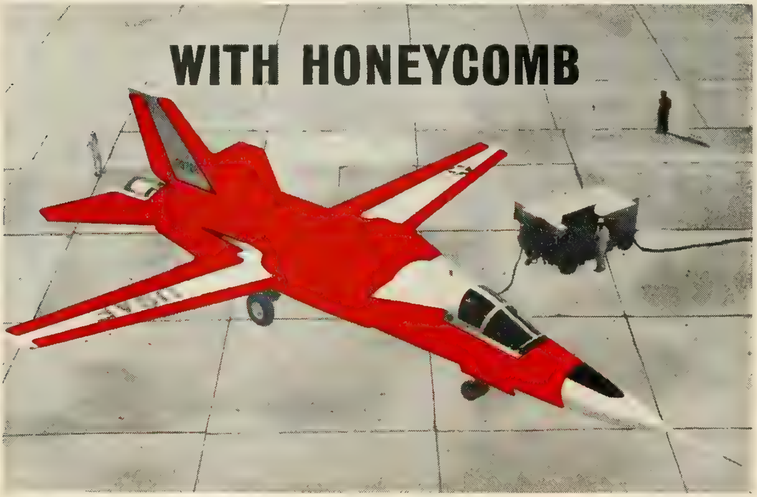
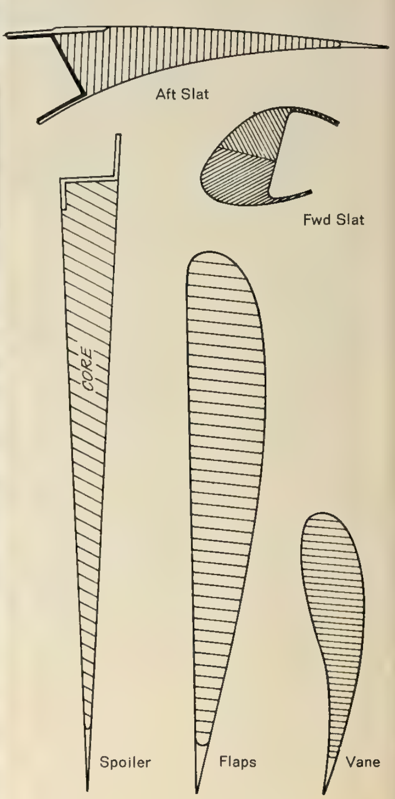


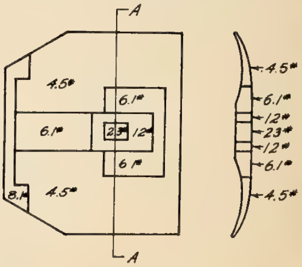


Typical Honeycomb Sandwich Contours

CORE IN WING



DISSIPATION OF CONCENTRATED LOAD—
Varying Core Density Saves Weight
8.1# = 8.1# Per Cu. Ft. Density



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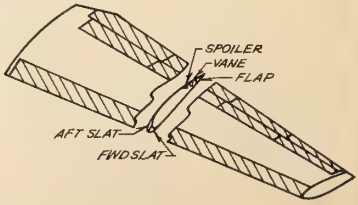

When General Dynamics was awarded the contract for the bi-service F-111, a production honeycomb core didn't exist that would perform properly in some applications at Mach 2.5.

Hexcel created one—honeycomb made of 2024 aluminum alloy.

Most of the honeycomb aft of the main landing gear, a Grumman responsibility, is 2024 sandwich. The rest is 5052 and 5056 aluminum, plus reinforced fiberglass honeycomb in the radome of the Navy version.

Typical contour configurations are demonstrated at right.

General Dynamics and Grumman are up-to-date on honeycomb technology. Are you?

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Technical Countdown

MATERIALS

Graphite Filament Properties Tripled

An intermediate grade carbon filament is being produced in appreciable quantities by Union Carbide Corp. with a strength modulus of 20 to 25 million psi. Some results have reached 30 million psi modulus with filament samples. In addition, the graphitic filament has tensile strengths in the 180 to 200,000 psi range, with some data indicating levels as high as 250,000 psi. The firm is aiming at the 100 million modulus mark in graphite-type filaments with support from the Air Force Materials Lab. The current graphite filament will be available in amounts large enough to start working on its behavior in composite structures—the ultimate reason for the filament effort.

PROPULSION

UTC to Build RENE Solids

A series of 2,500-lb.-thrust solid rocket motors will be designed, built and qualified by United Technology Center for use in wind tunnel tests of air-augmentation techniques. The $600,000, 64-week contract from Martin Co. is part of the RENE air-augmented rocket effort funded by the Air Force through Martin. The tests and associated engineering studies are designed to determine the best configuration of ejector shrouds, mixing aids and inlets in an air-augmented rocket.

Thiokol's SPARM To Fly

Three SPARMS—Solid Propellant Augmented Rocket Motors—are scheduled for flight testing at the Western Test Range. The air-breathing solids, developed by Thiokol Chemical Corp.'s Huntsville, Ala. division, inject fuel-rich products from a primary combustion chamber into a secondary chamber and mix with air to produce a combustible mixture. Air-breathing propulsion systems have been under development at the Huntsville operation since 1954.

ELECTRONICS

Repetitive MHD Pulse Generator Under Study

The feasibility of producing repeated, short-duration impulses of high-energy electric power with a magnetohydrodynamic generator will be demonstrated by Avco-Everett Research Lab for the Air Force's Aero Propulsion Lab. The work is an outgrowth of the development of the Mark V generator for the Advanced Research Projects Agency. This generator is a self-excited steady-state, rocket driven unit. It has achieved a d-c output of 31.3 million watts, including 7.7 million watts to energize its magnetic field. Demand power applications include wind tunnels, lasers, radar systems and other defense needs.

Laser-Seeker Captive Flights Contracted

Martin-Orlando is starting a nine-month laser-seeker captive flight test program for the Air Force Air Proving Ground Center, Eglin AFB, Fla. The $178,000 contract will evaluate laser target signatures and the general feasibility of laser systems for missile guidance and fire control. The Orlando Div. has been active in company-funded development of laser illuminators and seekers for missile applications. Some of these units will be used in the Air Force program.

Electron Tube Withstands Launch Shocks

A ceramic-metal type of photomultiplier designed to take the rigors of blast-off and vehicle landings in interplanetary operations is being marketed by the RCA Industrial Tube and Semiconductor Div. The C70144 is a 10-stage, venetian blind head-on type photomultiplier having a 2-in.-dia. aluminum oxide window and an RCA bialkali photocathode in stacked ceramic-metal construction. Dynodes are attached to metal rings that become part of the envelope, alternating with ceramic ring spacers. The entire assembly is sealed together by a brazing technique.

Domeless Solar Scope Erected In Germany

A domeless solar telescope of the Coudé refractor type, developed and built by Carl Zeiss, Oberkochen, is being erected at the Capri Observatory of the Fraunhofer Institut of Freiburg, Germany. The elimination of a protective dome is expected to provide highly improved images of the Sun's surface. A double tube technique is used to avoid the schlieren effect caused by rising, shimmering currents of hot air. Small regions of the Sun can be isolated using a rotating diaphragm in front of the mirror.

Improved Radar Computation Promised

A technique for computing radar cross-sections of retrodirective antenna arrays developed by Electronic Specialty Co. aids design of radar-augmentation and signature-modification systems. A network analysis approach, developed by the firm's Los Angeles Electronics Div., takes into account scattering from the antennas and metallic surfaces they are mounted on, antenna mutual coupling effects, and transmission line mismatch. Previous design work has used the approximation that energy received by an antenna is reradiated by its mate.

Solar Cell Radiation Damage Correctable

Silicon solar cells damaged by electron radiation can be completely recovered any number of times by subjection to high temperatures for a period of minutes. Dr. P. H. Fang, Thermal Systems Branch of Goddard Space Flight Center, says his discovery may lead to solar cell arrays immune to space radiation. An N-on-P silicon solar cell had its 11% efficiency reduced to 8% by radiation, yet 15 minutes at 390° C brought the damaged cell back to its original efficiency. The same cell was recovered repeatedly.

SPACE MEDICINE

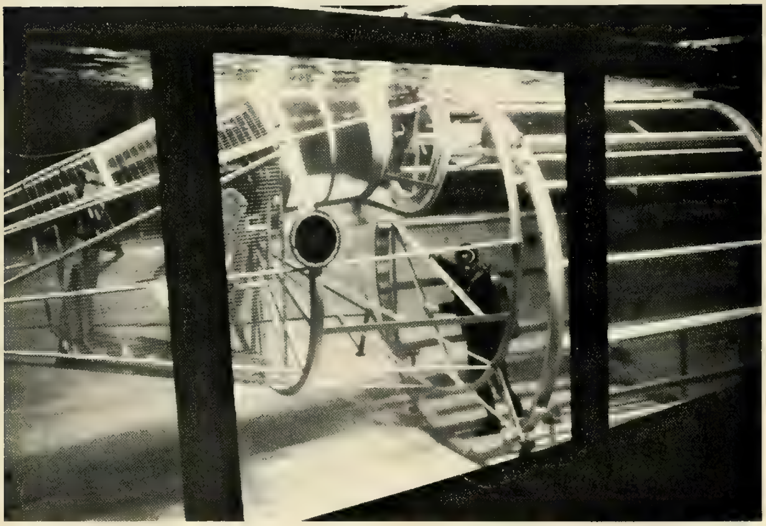
Soviets Consider Drugs To Fight G Forces

Soviets are recommending the use of strychnine nitrage, pheamine and other drugs to increase resistance to acceleration during re-entry after prolonged spaceflight. In a recent technical paper, Soviet scientists P. V. Vasilyev, and A. R. Kotovskaya said that ground tests showed that tolerance for 7 to 8 g's, after complete bedrest for 20 days, decreased to 4-6 seconds as against 4-5 minutes for normally functioning controls.

Zero-G Slows Astronaut Performance

Movement between MOL and Gemini capsule probed in 'neutral buoyancy' tests at GE; new tethering device may result

by Heather M. David



UNDERWATER tests conducted by GE at the Philadelphia Aquarama employ hardware simulating the Gemini capsule, left, an adapter section and the MOL canister, right. Tunnel between capsule and canister appears at top center in adapter section.

GENERAL ELECTRIC researchers simulating weightlessness problems of the *Manned Orbiting Laboratory* through underwater immersion are concluding that the absence of gravitational force may result in a substantial increase in the time required to perform any task.

The phenomenon, which has also been reported by the Soviets in their *Voskhod* flights and has been alluded to in the *Gemini* series, was studied by a group led by Theodore Marton in a series of well-calibrated tests designed to get precise answers on the value of underwater simulation, substituting "neutral buoyancy" for weightlessness.

The same program has led to the evolution of devices to aid astronauts' performance and a better understanding of the human factors problems anticipated in the *Gemini-MOL* combination. In recent experiments, the group has looked at such problems as the transfer of an unconscious astronaut from the *MOL* to the *Gemini* through the heat shield hatch, and extravehicular operations.

All of the experiments have been designed to be reproduced in the KC-135 aircraft to fly in the weightless trajectory, which phase GE hopes to proceed with in the near future.

Results of the company-funded program, which has been under way at the Philadelphia Aquarama each night from 5 to 12 o'clock for the past few months, include:

—Development of a tether line that can be made rigid in any position or left slack as the astronaut wishes, allowing its use as a restraining device, a ladder, or a means to move about;

—Development of a better understanding of procedures for movement between the *Gemini* and *Manned Orbiting Laboratory* and out of the *Gemini* for extravehicular experiments in the weightless state;

—Conceptual design of restraining devices for use inside the cabins of both vehicles to aid in performance;

—Verification that neutral buoyancy appears to be a reasonable way to simulate the parameters of weightlessness that have a significant effect on human motor performance but cannot be used to simulate the effects of weightlessness on any activity in which the human vestibular system plays a key part.

Six engineers, psychologists and designers working in GE's *MOL* program were selected for the study and pretrained in SCUBA and hookah use.

The tests took place in the 60-ft.-long, 22-ft.-wide Aquarama pool, which with its special lighting and transparent Herculite pool walls was ideal for viewing experiments taking place in the pool. The porpoises that usually perform during the day were displaced during the evening hours for the experiments.

All experiments were run through first in normal gravity outside the pool to get baseline data.

- **Slow motion**—The GE tests indicate, project leader Ted Marton told MISSILES AND ROCKETS, that no matter what the restraint, the total elapsed time in reaction time and functional spatial location tests in the submerged neutrally buoyant condition was more than in normal gravity conditions. The increase in some instances was as much as 50%.

At first, Marton said, it would seem that the time delay might be due to the retarding influence of hydrostatic drag or the planing deflection caused by movement through the denser medium. However, some of the tests were constructed so that no displacement or gross movement was necessary, ruling out the possibility that drag caused the delay.

The novelty of the situation probably also had little bearing, Marton pointed out, since the subjects were trained and had practiced before the formal tests began. Each man's performance in the normal gravity state and submerged state was measured and compared, and while there were differences between individuals, each man demonstrated the same increased time in the simulated weightless condition.

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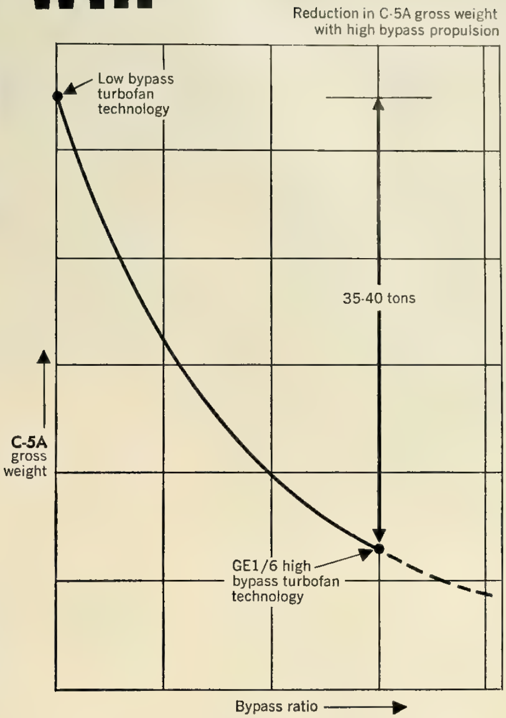

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The military program is scheduled for eight years, and the technical work life is expected to be twice that. Equally intriguing are the potential future derivatives of the GE 1/6, and their implications for radically reducing passenger and cargo costs for large commercial transport aircraft.

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The researchers are anxious to perform the the same tests in weightless aircraft flights to see whether the same phenomena is manifested.

The first series of tests in the tank were aimed at measuring reaction time, with the subjects pushing buttons in response to lights on the console. In this test, their fingers were already placed on the buttons, and little pressure was needed to perform the proper response.

While reaction times were universally longer, coordination efficiencies were found to be unimpaired, and values in eye-hand coordination, spatial location and precision alignment tests were the same as in normal gravity.

Spaceflight experience also has shown that the astronauts have had no loss in precision eye-hand coordination tasks, Marton points out. The crews have been able to maneuver their craft just as well in orbit as in ground simulations, and have performed expertly during re-entry.

- **MOL simulated**—The equipment used in the tank included full size metal frame mockups of the *Gemini* and adapter, and *MOL*, including an enclosed tunnel through the heat shield area between the two compartments. Photographs were taken of the men's movements in relation to the equipment to get precise human factors information.

The subjects were divided into several groups, Marton said, including a team of "chubbies" and a team of smaller men chosen because they fit into the general size range of the astronauts. Others acted as safetymen throughout the experiment. Marton said that this division was made to get information on what the worst possible size situation would entail in addition to the more probable situation.

Neutral buoyancy was achieved by placing lead weights in the divers' wet suits until the subjects neither rose, sank nor rotated to any specific position in the water.

- **MOL tests**—Since the *MOL* program will offer opportunities to move around not present in the *Gemini* alone, the problems of changing from a two-dimensional situation, as that on Earth, to a three-dimensional one of weightlessness were studied.

A series of five different types of magnetic shoes were tested, Marton said, but none were found to be very useful. Walking is not the appropriate form of movement, the researchers concluded.

A second study dealt with the problems of moving and assembling pieces of equipment, such as that to be used in experiments. Marton said it was quickly determined that all devices for connecting pieces of equipment must be connected immediately or be self-locking, or they will drift away as an additional one is moved up. Connecting devices are being designed on the basis of this study.

During this phase, the men studied the problems of assembling the kind of nested items that might be used in space, such as a 500-lb. telescopic-like device which would have to be fixed in place and assembled.

The problem of bringing an unconscious astronaut from the *MOL* back into the *Gemini* were simulated, using a tunnel partially made of Plexiglass for monitoring. While at first it was reasoned that the most efficient way would be to push the disabled man through headfirst so that his arms and feet would not fan out and block the entrance, this was not satisfactory.

Eventually, a technique was settled upon in which a single bungee cord could be looped quickly around him to secure his appendages, and enable another astronaut to pull him through by his feet.

Another phase of the tests involved studying the problems of donning spacesuits in the zero-g condition. It was decided that the best restraint to keep the astronaut from being propelled around the cabin by his movements would be to design a toe-hold to secure one foot as the suit is donned. The toe-hold consists of a mushroom-shaped object on the cabin floor fitted with a toe-trap skirt developed by GE for laboratory console work as well.

VERSATILE tether design developed in tests is used here as a restraining mechanism by subject in 'neutral buoyancy' facility.

- **EVA**—A look at the problems of operating on a long tether appeared to verify the studies carried out at Wright-Patterson AFB by the Air Force several years ago. These concluded that a man on the end of a long tether trying to pull himself hand-over-hand would start rotating and build up a velocity which would lead to a terrific impact with the spaceship.

To avoid this situation, a restraint line was developed that operates in principle like a child's toy in which a toy animal is made to stand erect or fall limp by pushing a button at the base which operates strings in its body.

The tether, constructed of aluminum balls and collars strung on a line, also can be made erect or limp by a movement of the astronaut's hand. By making it stiff, the astronaut could check his speed toward the ship while pulling himself back on the same line.

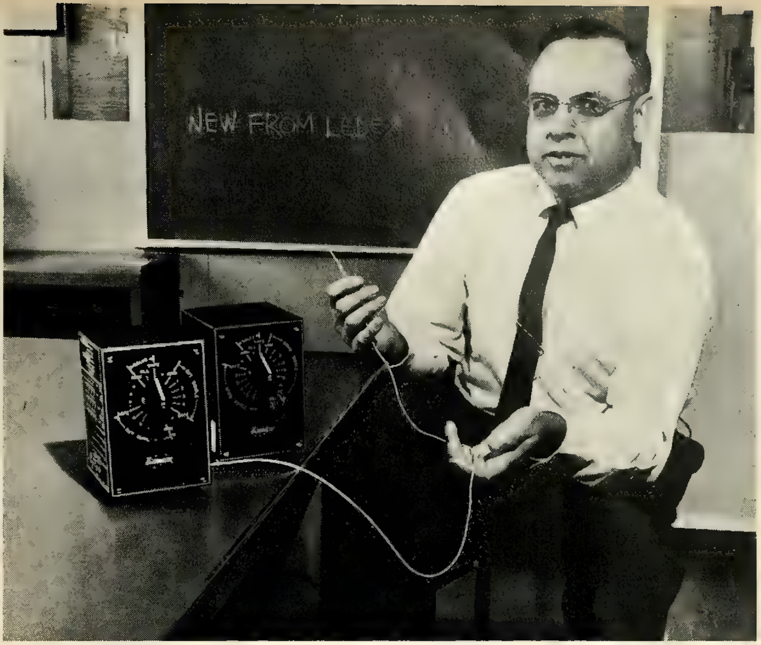
The same device could be used inside the cabin to restrain the men performing laboratory experiments, or it could be looped around the astronaut's body or neck and made stiff in that position to free his hands as he makes repairs outside the ship, Marton pointed out.

The line can also be bent into any shape, making right angle turns to go around corners. For the submersion tests, it was constructed of walnut blocks and aluminum collars to render it neutrally buoyant for simulation.

- **Laboratory restraint devices**—Three kinds of harness and restraint devices which might be considered for *MOL* work were evaluated. The first, a hand-hold consisting of a curved aluminum tube railing placed at hip height in front of the consoles, was found to be the least satisfactory.

The other two, one a thigh-trap, the other a toe trap, were found to be acceptable. The thigh-trap is a rotating removable seat-like apparatus that clamps in the same manner as the hook posts of a ladies' side saddle. The toe-trap consists of a flexible rubber skirt placed at the base of each console, which compresses the subject's foot against the floor. All were made fail-safe, so that the astronaut would be freed if the device broke.

- **Unlike weightlessness**—In a general evaluation of the neutral buoyant state in its similarity to weightlessness, it was concluded that the effect of gravity upon the vestibular system cannot be changed in any way. In a series of tests in which the subjects were purposely spun in three directions with their eyes closed to determine if they could sense the upward direction, the scores showed conclusively that the cues which appear to act upon the otoliths cannot be removed by this method. ■



We had only one wire and 9 volts to operate these new control systems

These two boxes sit side-by-side in the belly of a non-expendable armament pod . . . which is attached to Northrop manufactured jet fighters used for combat training.

Inside each box is a 3-mode intervalometer which includes a selector switch and timing control circuitry. One box controls the release of 6 practice bombs. The other controls the firing of 4 rockets. In each case, control can be exercised in single, ripple or salvo patterns.

Now for the special requirements they gave us: "Design it to use existing wiring."

This put us out at the end of a single wire that had a 5-ohm resistor on it. As a result, what we had to work with was an input of less than 9 volts.

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Electric Systems Urged For 1970-75 Missions

by Rex Pay

PASADENA, CALIF.—Joint Air Force/NASA feasibility studies of solar-powered electric propulsion indicate that such systems are competitive with all-chemical propulsion for many interplanetary missions and should be considered for use by 1970-75.

Aim of the current joint studies is to examine the feasibility of using large lightweight solar arrays to drive electric propulsion units at powers of up to 50 kw. The studies are also examining how to integrate the power and propulsion systems into spacecraft concepts.

Final reports of a number of parallel nine-month studies are to be submitted next January. They will detail the various spacecraft concepts studied and are expected to indicate a breakthrough in interplanetary spacecraft capability.

Work by Boeing indicates that solar cell arrays providing up to 50 kw can be fabricated with total weights less than 50 lb./kw. Electro-Optical Systems and Hughes Aircraft has each developed complete ion engine systems that offer weights as low as 25 lb./kw and even 20 lb./kw.

For Jet Propulsion Laboratory mission analysis, the combined solar power, power conditioning, and ion propulsion systems have been assumed to have a total weight of 75 lb./kw and to operate at 4,000-5,000 seconds specific impulse. For *Voyager* type spacecraft launched by a *Saturn IB-Centaur,* this propulsion system doubles the weight that can be inserted into Mars orbit.

Titan III with a Transtage could put an orbiter around Mars as heavy as that envisaged for the *Saturn IB-Centaur Voyager* mission, if solar electric propulsion were used.

Most of the JPL studies have considered Mars missions, as these provide a readily available set of parameters for comparing chemical and electric propulsion. Now that *Saturn V* has been selected as the *Voyager* launch vehicle, however, there is little likelihood that an electrically propelled Mars mission will be funded.

- **Jupiter trip usage**—Most likely candidate for use of solar-electric propulsion is a Jupiter mission. JPL has been investigating highly elliptical trajectories that involve an initial sharp swing toward the Sun. The electric propulsion would operate during this period and perhaps on out to the orbit of Mars. Then the propulsion would be shut off and the power from the large solar array would operate experiments, communications, and other onboard equipment.

According to John Stearns, assistant manager of JPL's propulsion research and advanced concepts section, most of the mission parameters for the solar-electric propulsion studies were drawn around the *Saturn IB-Centaur* booster combination, recently deleted from the *Voyager* program. Typically a spacecraft with 25 kw of onboard power would be used. This would call for some 2,500 sq. ft. of solar cell area.

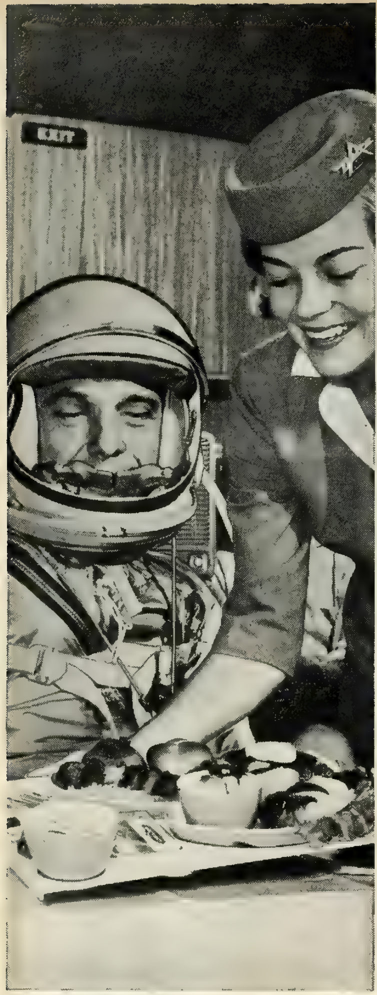
To obtain such large solar panel areas, various forms of unfolding and unrolling panels are being evaluated.

The actual weight put out to Mars when electrical propulsion is used is only a small amount above that put out by purely chemical means, said Stearns. However, the electrically propelled spacecraft approaches Mars with a much lower velocity. This cuts retropropulsion requirements for an orbiter.

Typical trajectories being studied for *Voyager* chemically propelled missions in 1971 involve a 200-day flight and an approach velocity of 3.5 km/sec. Use of solar-electric propulsion would mean a 300-day flight and an approach at less than 1 km/sec.

Mars payloads vary from year to year because of the planet's position relative to Earth. Although 1977 will be an unfavorable year for chemical propulsion to Mars, the weight reduction for electric propulsion is not nearly so severe, said Stearns.

- **Underwriting**—Under the joint program, the Air Force is funding fabrication of a propulsion subsystem and is obtaining a subsystem life test at Electro-Optical Systems, Pasadena. NASA is funding a subsystem test of an



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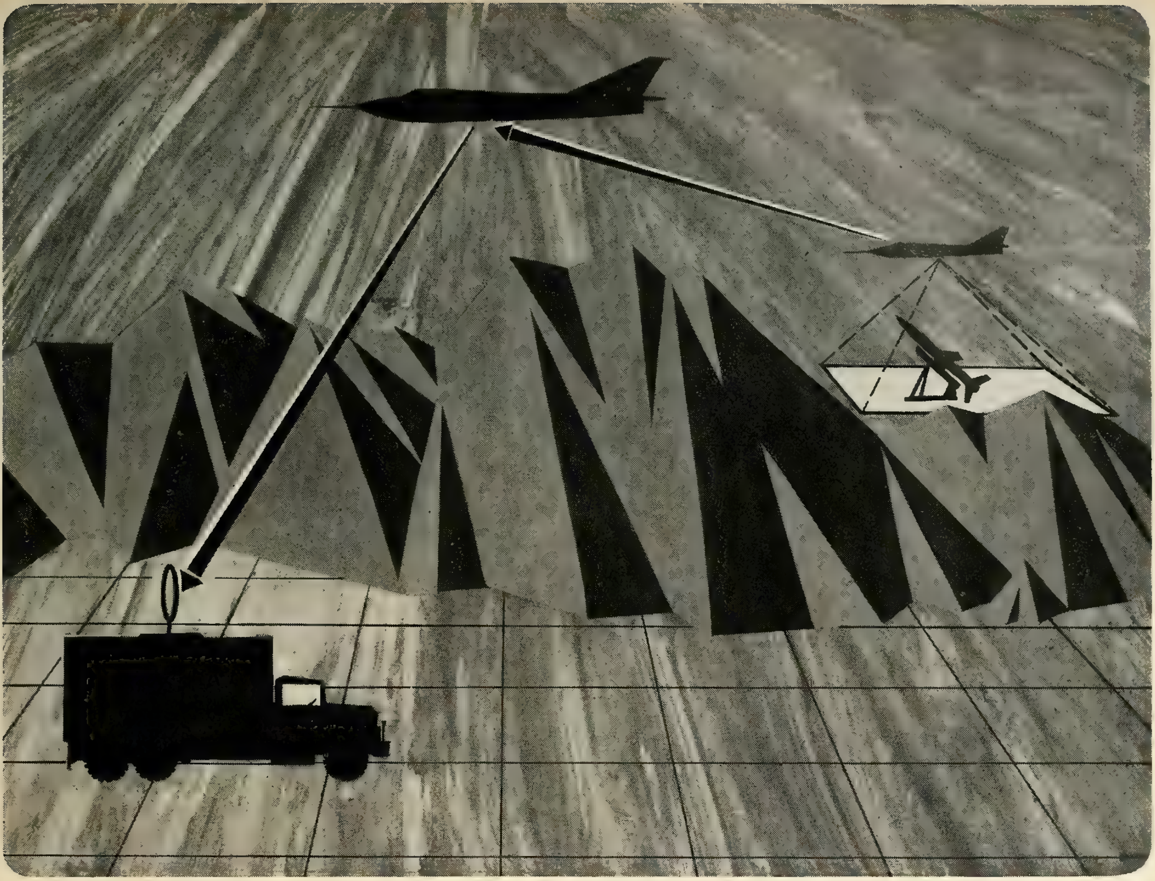

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Electrical Engineers
Automatic Test Systems. Requires experience analyzing design requirements to control product quality.
Structures
Structural elements, thermal protection systems, pressure vessels. Conceive, design components/systems.
Propulsion Design
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Advanced Propulsion systems
Set preliminary design criteria for solid and liquid systems
Control Systems Engineers
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Ground Support Equipment
Design & test ground support equipment. Design electrical systems.
Chemist/Chemical Engineer
Design, develop: Electrochemical, life support devices and pre-treatment techniques for waste fluids.
Chemist—Fuel Cells
Applied electrode technology catalysis, or electrochemical technology.
Mathematician
PhD. Help make new, special purpose computers/programs.
Battery Technologists
Design, fabricate, test: High energy density batteries, electrodes, separators, cases, seals, components.

electric propulsion system at Hughes.

The Hughes and EOS spacecraft concepts are competitive and involve engines of about 1 kw power. A 500-hr. life test of each system is scheduled for completion by the end of the current fiscal year. Apart from this test, the propulsion and spacecraft system studies are scheduled to be finished by December. Boeing's work on the solar power system should be completed by November.

Engineering direction for the Air Force ion propulsion development comes from the Air Force Aero Propulsion Laboratory, Wright-Patterson AFB.

The NASA side of the program involves NASA headquarters, the Space Nuclear Propulsion Office, and JPL. Results of the studies are being monitored by the Office of Space Sciences and Applications long-range planning group at NASA, which will recommend whether or not solar-electric propulsion missions should be pursued further.

Reliability studies proceeding at JPL will determine the optimum number of propulsion system modules. A preliminary analysis suggested 10, said Stearns. As a spacecraft launched by *Saturn IB-Centaur* would require about 25 kw, the initial analysis indicated that the electric propulsion subsystems would be sized at 2½ kw each. This figure would be halved for a *Titan III*.

- **Power supply consideration**—Solar panel studies at Boeing are being carried out under a nine-month contract for about $250,000. Preliminary designs of 10-kw and 50-kw arrays are under way and ground support equipment requirements and the problems of coupling large solar arrays to propulsion systems are being analyzed.

At the present state of the art, a modular construction of solar panels that can be folded up into a small volume appears to be the most promising. Boeing is currently building up some small samples of its solar panel modules in the form of 1-sq.-ft. sections.

Initial indications were that the optimum solar cell system would use a 2-4 mil coverglass, 8-mil thick n-on-p solar cells, and H-film or glass fiber tape mounting.

Under another contract, Ryan Aeronautical Co., San Diego, is working on the design, development, and fabrication of a deployable supporting structure for 200 sq. ft. solar cell arrays. The design chosen involves four individual assemblies, each capable of deploying 50 sq. ft. of solar cells. The substrate for the cells is a 216-in. length of laminated glass-fiber woven cloth that is wrapped around a drum. An electric motor turns the drum to deploy or retract the panels.

Hughes is developing large-area roll-up solar arrays under an Air Force contract. ■

Artificial Sun Illuminates Lunar Model

MORE THAN 400 individual lights are used in the collimated light source in the background to simulate sunlight as it strikes a model of the lunar surface in Boeing Co.'s visual spaceflight simulator. The light source produces nearly parallel light rays, which, in turn, cast sharp shadows on the simulated lunar surface, similar to those an astronaut would see when approaching the Moon.

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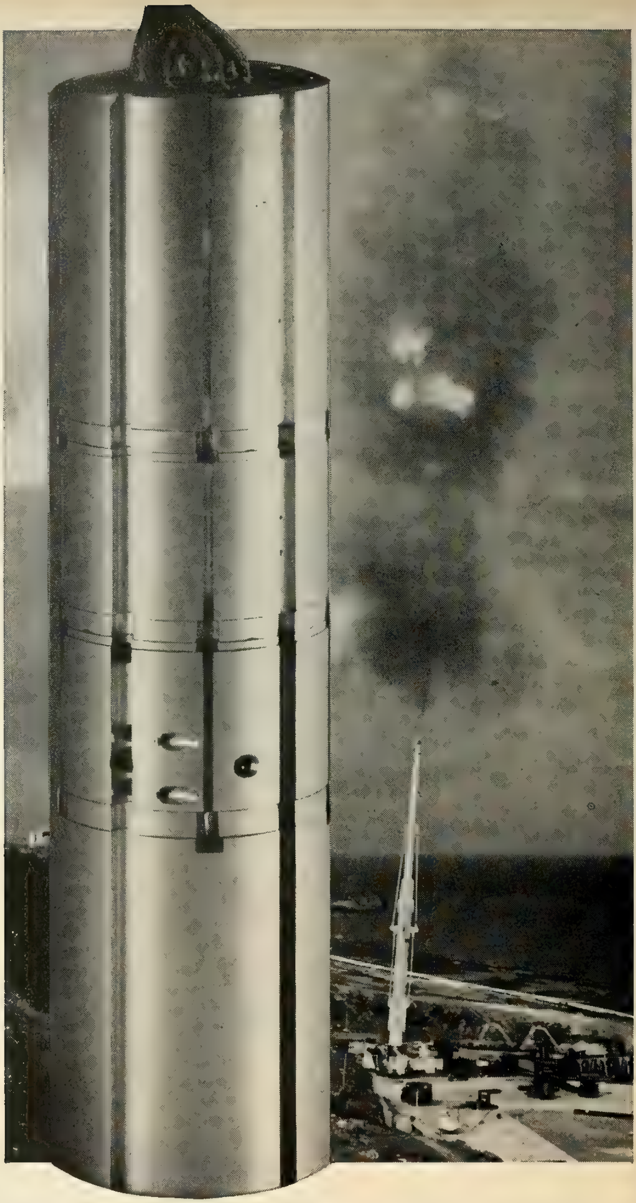

At Computing Devices' Space Sciences Division, solid state telemetry systems, such as the one above are created to withstand accelerations of more than 50,000 g. These consist of a power supply, inertia switch, voltage regulator, voltage-controlled oscillators, a commutator and a 215-260 Mc, F.M. transmitter. ☐ Developments of the Space Sciences Division include high g telemetry systems for aeroballistic ranges, gun-launched upper-atmosphere research vehicles, high acceleration rockets and missiles and hard-landing instrumentation. For information, please write Space Sciences Marketing Manager at address below. ☐ *If you are looking for a career in the exciting, expanding world of aerospace sciences, opportunities are open in these areas :— aerodynamics, ballistics, impact physics, gas dynamics, thermodynamics, solid state physics as well as mathematics, physics and engineering. Inquiries from qualified applicants should be sent in confidence to the Director, Industrial Relations and should refer to File No. 3810.*

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The Industry Week

New Activities

Information Sciences, Inc., a subsidiary of Brown Engineering Co., Huntsville, Ala., has established a commercial systems operation in Birmingham. Information Sciences is based in Atlanta. . . . *Hewlett-Packard Co., Palo Alto, Calif., has consolidated its Mechrolab Div., presently located in Mountain View, Calif., with its F&M Scientific Div. in Avondale, Pa. Intent of the move is to combine operations on related lines of equipment. Mechrolab makes instruments for chemical and physical analysis, including osmometers and automated viscometers. F&M Scientific produces gas chromatographs. The transfer of operations is expected to take place by early 1966.*

Mergers and Acquisitions

Teledyne, Inc., Los Angeles, has reached agreement in principle to acquire Hydra-Power Corp. of New Rochelle, N.Y., a manufacturer of aerospace and aircraft test instruments and laser welding equipment. Teledyne will issue about 75,000 shares of stock, valued at $3.6 million, for the acquisition. . . . *Greater Washington Industrial Investments, Washington, D.C., and Continental Capital Corp. of San Francisco have purchased Western Microwave Laboratories, Inc., the Santa Clara, Calif., subsidiary of Keltec Industries, Inc., Alexandria, Va. Western Microwave designs, makes and sells a line of microwave components and subsystems. No changes in management or operating procedure are planned. Cost of the transaction was not revealed.* . . . Electronic Communications, Inc., stockholders have been asked to consider a proposal that the firm merge with its Benson Manufacuring Co. subsidiary in Kansas City, Mo. The stockholders will meet Nov. 23. Approval would result in Benson's becoming a division of Electronic Communications. ECI, located in St. Petersburg, Fla., produces command and control communications systems, electronic equipment and accessories for defense and space programs.

International

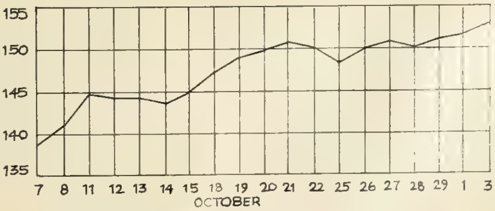
Computing Devices of Canada, Ltd., Ottawa, has established a new Space Sciences Div. to be responsible for a variety of space-oriented programs in the fields of applied physics, research, mechanical engineering, scientific analysis, high-g electronics, and scientific services. Space Sciences will also assume responsibility for range management, under contract from the Space Research Institute of McGill University, of the *HARP* project. . . . *Control Data Canada, Ltd., a subsidiary of Control Data Corp. of Minneapolis, Minn., has purchased the computer systems division of Computing Devices of Canada, Ltd., for an undisclosed amount of cash.* . . . A joint venture consisting of S. Smith & Sons, London, and GAP Instrument Corp. of Westbury, N.Y., has purchased the Gorn Electric Co. of Stamford, Conn. Gorn designs and produces a line of precision pressure-sensing switches and devices for space and air vehicles. Gorn will also manufacture and distribute in the United States new products for the commercial aviation market formerly available only by import from Smith's Aviation Div. . . . *Scientific Data Systems, Los Angeles, has formed a new wholly owned subsidiary, Scientific Data Systems of Canada, Ltd., in Ottawa to sell the company's computers and systems in Canada.*

Facility Expansions

Giannini Controls Corp. has announced plans to move its corporate headquarters from Duarte, Calif., to New York City next spring. Nine corporate officers and senior executives will make the move with the office. The transfer is an effort to keep in close touch with the firm's changing business activities, which have expanded widely in the Northeast. . . . *American Avitron, Rye, N.Y., has broken ground on a headquarters addition that will double the firm's existing manufacturing and engineering space. The new structure is expected to be completed this fall and will house an expanded manufacturing area for the fabrication of aerospace ground support equipment.* . . . Applied Science Industries, Inc., Falls Church, Va., has opened a third manufacturing facility in Springfield, Va., to operate as the Rocket Div. The new plant will be primarily engaged in the manufacture of rocket and missile components. . . . *Canoga Electronics Corp., Chatsworth, Calif., has broken ground on a new 20,000-sq.-ft. headquarters for its Remanco Div. adjacent to corporate headquarters. Remanco activities will all be moved to the new site from Santa Monica when the building is completed in January. Cost of the facility is estimated at $650,000. An additional facility of similar size is planned for a later date. Production work will be integrated into the present Canoga plant.*

Missile/Space Stock Index

High third-quarter earnings reports for the 19 companies in the Missile/Space Stock Index contributed to a continued high level, staying near and above the 150 mark for more than a week. A story in the *Wall Street Journal* predicting a defense budget of $55 billion or more also added to interest in these stocks.



100 = CLOSING PRICES OF 19 REPRESENTATIVE AEROSPACE FIRMS DEC. 31, 1964
STOCK PRICES FURNISHED BY MERRILL LYNCH, PIERCE, FENNER AND SMITH

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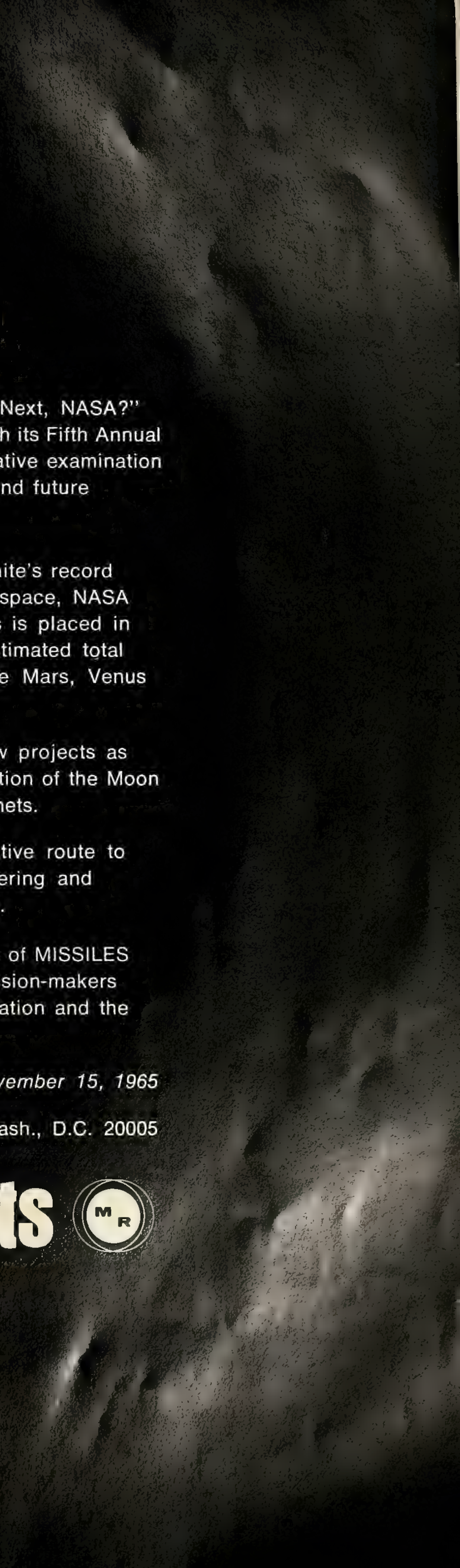

what's next, nasa?

MISSILES AND ROCKETS asked this probing question, "What's Next, NASA?" And on November 29, 1965, MISSILES AND ROCKETS will publish its Fifth Annual NASA Issue with answers to this question as well as an authoritative examination of the National Aeronautics and Space Administration's current and future projects and facilities.

After a year of spectacular achievement, including Astronaut White's record extravehicular space walk and Gemini 5's record 191 hours in space, NASA is looking ahead to its new space programs. Special emphasis is placed in this issue on the Apollo Applications Systems, which have an estimated total cost of over $1 billion, and project Voyager, which will explore Mars, Venus and other planets.

This special issue will also explore NASA's plans for other new projects as the U.S. space program begins its swing away from the exploration of the Moon to the vaster and more challenging mission of probing the planets.

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BONUS CIRCULATION: By request, the fifth annual NASA issue of MISSILES AND ROCKETS will provide 5,000 bonus circulation to the decision-makers in Government, the Atomic Energy Commission, ComSat Corporation and the National Aeronautics and Space Administration.

Publication Date: November 29, 1965 *Closing Date: November 15, 1965*

American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Wash., D.C. 20005

missiles and rockets M R

THE WEEKLY OF ADVANCED TECHNOLOGY

AIR FORCE

$34,833,725—**Aerojet-General Corp.,** El Monte, Calif., to produce Stage II motors for *Minuteman* missiles in Sacramento, Calif.

$27,235,000—**The Boeing Co.,** Seattle, to continue modernizing *Minuteman* missiles near Whiteman AFB in Knob Noster, Mo.

$11,617,270—**Sperry Rand Corp.,** New York, N.Y., to make electronic data-processing equipment.

$6,736,143—**Systems Development Corp.,** Santa Monica, Calif., for continued design and development of electronic information and communications equipment.

$6,000,000—**Sylvania Electric Products, Inc.,** Waltham, Mass., initial funding to produce a command and control system for 50 *Minuteman II* missiles and five underground control centers for the missiles.

$1,393,015—**Monmouth Electric Co.,** Neptune, N.J., communications equipment.

$1,200,000—**Martin Marietta Corp.,** Friendship Int'l Airport, Md., to manufacture environmental control equipment for *Titan II* missile in Denver.

$1,200,000—**International Telephone and Telegraph Corp.,** New York City, fixed-price for base support services.

$1,044,120—**Radiation, Inc.,** Melbourne, Fla., for modification of space-telemetry antennas.

$1,038,444—**Collins Radio Co.,** Dallas, for production of components for high-frequency communications sets.

$206,426—**Avco Corp., Research and Advanced Development Div.,** Wilmington, Mass., three contracts to advance techniques for nondestructive testing of aerospace materials.

$194,554—**Dow Chemical Corp.,** Midland, Mich., for investigation and compilation of the thermodynamic properties of rocket exhaust products.

$178,000—**Martin Co., Orlando Div.,** Orlando, Fla., for a laser-seeker captive flight test program.

$134,996—**Rocket Power, Inc.,** Mesa, Ariz., for study of thermodynamic properties of rocket exhaust products.

$69,800—**Defense Research Corp.,** Santa Barbara, Calif., for research on explosive instabilities in condensed phase monopropellants.

ARMY

$41,071,861—**General Dynamics Corp.,** New York, to continue production of *Redeye* air defense rockets.

$29,300,178—**FMC Corp.,** New York, two contracts to make vehicles in Charleston, W.Va.

$2,900,000—**Rohm & Haas Co.,** Philadelphia, to continue research and development on missile propellant programs.

$1,658,970—**Lockheed Aircraft Corp.,** Burbank, Calif., for continued research and development on range instrumentation equipment for the White Sands, N.M., missile range.

$1,245,914—**Sperry Rand Corp.,** New York, to produce electronic components for the *Sergeant* missile in Salt Lake City, Utah.

$1,021,746—**Federal Labs., Inc.,** Saltsburg, Pa., for chemicals.

$276,000—**Northrop Corp.,** Newbury Park, Calif., for AQM 38A missile target drone services.

NAVY

$13,451,061—**Westinghouse Electric Corp.,** Baltimore, for modification of radar sets.

$1,009,000—**Dynamics Corp.,** Stoneham, Mass., letter contract to upgrade and expand shipboard equipment used for tropospheric-scatter communications.

$267,736—**Lockheed Propulsion Co.,** Redlands, Calif., for solid-propellant rocket motors with igniters.

NASA

$1,200,000—**Federal Electric Corp.,** Paramus, N.J., add-on for instrumentation services to Merritt Island Launch Area, Kennedy Space Center.

$290,000—**North American Aviation, Inc.,** Rocketdyne Div., Canoga Park, Calif., from Manned Spacecraft Center for *Apollo* Command Module RCS rocket engines, oxidizer valves and fuel valves.

$280,000—**Operations Research, Inc.,** Silver Spring, Md., from Goddard Space Flight Center to independently monitor and recommend specific improvements in the reliability aspects of the *Advanced Orbiting Solar Observatory*.

$242,044—**TRW, Inc.,** Florida Operations, Cape Canaveral, Fla., from Kennedy Space Center for checkout and launch systems engineering study of *Apollo* applications program.

$224,000—**Goodyear Aerospace Corp.,** Akron, Ohio, from Langley Research Center for construction and checkout of prototype transportable ground-based satellite photometer system.

$152,800—**Honeywell, Inc.,** Aeronautical Div., Minneapolis, Minn., from Manned Spacecraft Center for *Apollo* cockpit simulation devices.

$122,000—**Tracerlab, Div. of the Laboratory for Electronics, Inc.,** Waltham, Mass., for control of radiation sources, in space and on the ground for manned spacecraft.

$94,397—**Astro Research Corp.,** Santa Barbara, Calif., from Langley Research Center for development of design data for decelerators for use with unmanned planetary entry vehicles or manned space vehicles.

$93,613—**University of California,** Berkeley, Calif., from Manned Spacecraft Center for flight experiment to study trapped radiation.

$93,000—**IIT Research Institute,** Chicago, Ill., from Langley Research Center for development and fabrication of prototype combustible fiber mandrels for test firing.

$84,289—**Melpar, Inc.,** Falls Church, Va., from Manned Spacecraft Center for study of laser wave scattering due to refractive index perturbations in the propagating medium. Also $64,711 from Langley Research Center for flight type gas chromatograph.

$69,500—**Itek Corp.,** Vidya Div., Palo Alto, Calif., from Lewis Research Center for rocket engine ablative material phenomena program.

$64,710—**Aerospace Controls Corp.,** Los Angeles, from Manned Spacecraft Center for solar simulator.

$60,028—**General Dynamics Corp.,** San Diego, Calif., from Langley Research Center for study of freeze-out techniques for contaminant control with manned spacecraft atmospheres.

$60,000—**Varian Associates,** Vacuum Products Div., Palo Alto, Calif., from Manned Spacecraft Center for vacuum system for calibrating high vacuum.

$60,000—**Bio-Technology, Inc.,** Arlington, Va., from Headquarters for development and fabrication of three modified perceptual motor performance measurement consoles and a study of space environment variables using the consoles.

$56,500—**Chadwick-Helmuth Co.,** Monrovia, Calif., from Manned Spacecraft Center for phase amplitude and current control system.

$49,531—**Itek Corp.,** Vidya Div., Palo Alto, Calif., from Western Operations Office for solid rocket nozzle performance studies.

$47,410—**Hughes Aircraft Co.,** Culver City, Calif., from Langley Research Center for techniques for increasing long-range applicability of mission-oriented manual guidance and control research.

$31,820—**Electronic Associates, Inc.,** West Long Branch, N.J., from Manned Spacecraft Center, for computer test console and related parts.

$25,486—**Philco Corp.,** WDL Div., Palo Alto, Calif., from Western Operations Office for experimental study of coatings for temperature control of solar cells.

$25,000—**Lockheed Aircraft Corp.,** Missiles & Space Div., Sunnyvale, Calif., from Lewis Research Center for *Isis-X* mission spare parts.

INDUSTRY

$3,500,000—**Honeywell, Inc.,** St. Petersburg, Fla., **Goodyear Aerospace Corp.,** Akron, Ohio; **Leach Corp.,** Los Angeles; **Borg-Warner Corp.,** Pesco Div., Bedford, Ohio; **Sterer Manufacturing Corp.,** Los Angeles; United Electrodynamics Div. of **Teledyne Ind., Inc.,** Hawthorne, Calif.; and **Motorola, Inc.,** Phoenix, Ariz., from **Martin Co.,** Friendship Int'l Airport, Md., subcontracts for four maneuverable re-entry spacecraft for the Air Force.

$3,300,000—**Johnson Service Co.,** St. Louis, Mo., from the **Boeing Co.,** Seattle, Wash., for modification of *Minuteman* intercontinental ballistic missile sites.

$1,500,000—**Pennsalt Chemicals Corp.,** Stokes Advanced Systems Dept., Philadelphia, from **Sandia Corp.,** Albuquerque, N.M., to design, manufacture, install, and test a high-temperature re-entry simulation facility.

$1,050,000—**Radio Corp. of America,** Aerospace Systems Div., Burlington, Mass., from **Grumman Aircraft Engineering Corp.,** Bethpage, L.I., N.Y., for ground support equipment in connection with LEM program.

$200,000—**Radio Corp. of America,** Astro-Electronics Div., Princeton, N.J., increase for the APT tape recorder program.

$150,000—**Radio Corp. of America,** Communications Systems Div., Camden, N.J., increase from the **Boeing Co.,** Seattle, for the TAPS program.

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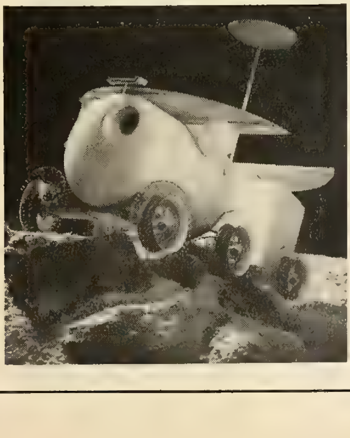
Resembling space-age "dune buggy," Boeing-proposed mobile lunar laboratory (MOLAB), would be sent to moon aboard Saturn V, serve as moon explorers' living and working quarters.



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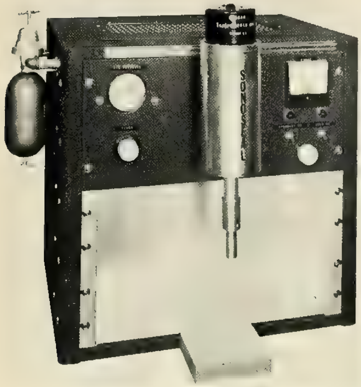
Electronic/Electromechanical Parts Evaluation
Computer Systems Analysis
Plant Facilities Engineering
Manufacturing Development
Welding Process Development
Brazing/Diffusion Bonding
Arming & Fuzing Technology
Tool Design
Quality Control
Management Systems Staff

Artist's early concept of unmanned Voyager spacecraft, which will explore the planets, beginning with Mars in early 1970's. Boeing is one of three companies picked by NASA for preliminary design studies.

New Product of the Week: Ultrasonic Plastic Welder



A series of SONOSEAL® ultrasonic plastic welders for use on rigid plastic structures has been announced by Edison Instruments, Inc.

Structures of high-impact polystyrene, Lucite, Delrin, Lexan, polyethylene and polypropylene are weldable in times from 0.2 to 2 seconds. Units come in a bench-mounting cabinet and include a 0- to 10-sec. weld timer, air cylinder, filter and regulator. They feature automatic tuning and range from the 75-watt model to the 300-watt model. A line of interchangeable tool tips is available.

Circle No. 151 on Subscriber Service Card

Temperature Controller

A bi-directional proportional temperature controller for both heating and cooling modes is being marketed by Harrel, Inc.

The Model CU-390 does not cycle on and off; thus, there is no oscillation of the controlled temperature. The device recognizes direction of any deviation in actual temperature from the set point and automatically changes output from one polarity to the other. Rate and reset actions are provided to neutralize effects of time lags within the thermal system. A go/no-go indicator provides a visual alarm.

Circle No. 152 on Subscriber Service Card

Differential Pressure Valves

M. C. Manufacturing Co. is marketing a series of differential pressure, in-line relief valves, featuring a special poppet damping device.

The valves, R26150 through R26-210, have "boosted lift action" hardened poppets that seat on sharp-edged hardened seats to provide leak-tight closures at all pressures below the re-seat pressure. They are available in four sizes with dimensions conforming to MS28893-4, -6, -8 and -12. Full flow capacity ratings range from 2.5 to 25 gpm with pressure settings from 800 to 3,850 psi.

Circle No. 153 on Subscriber Service Card

Engine-Generator Set

A self-contained electric power generating system, especially suited to applications where extremely close power and frequency tolerances are necessary, has been announced by Westinghouse Electric Corp.'s Aerospace Electrical Div.

The unit has electrical ratios of 60 kw power output, 120/208v and 400 cps. Rating can be changed to 240/416v. Other specifications include a voltage regulation of ±2%; voltage transients of ±15%. Operating temperature range is —65° to 125°F.

Circle No. 154 on Subscriber Service Card

Digital Guassmeter

The Model 660 digital gaussmeter, a precision Hall-effect instrument for measuring magnetic flux density, has been announced by F. W. Bell, Inc.

The unit offers both digital and analog readout capability. Decade scale ranging is used to provide a choice of full-scale ranges from 1 gauss (analog) or 100 gauss (digital) to 100 kG. Probes are available covering the ranges from 0.1 gauss to 30 kG. Accuracies up to 0.25% are attainable in the digital read mode between 0 and ±10 kc. Resolution of 1 part in 1,000 of reading is also attainable.

Circle No. 155 on Subscriber Service Card

Cavitation Meter

A meter designed to give instantaneous indication of the amount of energy released during the cavitation of liquid media is being marketed by Macrosonics Corp.

The Model CVM-3a gives readings proportional to the amount of noise produced during bubble collapse after reduction of the transducer signal contribution. The unit has a response time of less than 1 second and an extended frequency range up to 600 kc. It is calibrated with the carbon tetrachloride decomposition technique.

Circle No. 156 on Subscriber Service Card

Hot-Air Torch

A hot-air torch with a temperature capability of 1,000°F is being marketed by Henes Manufacturing Co.

The Model FT-200 has changeable tips ranging in diameter from 0.037 to 0.093 in., allowing the user to match the size of the superheated air stream to the application requirement. Temperatures and air flow at torch tip can be set for predictable and repeatable levels with a master control console. Dual air pumps provide a continuous air supply of up to 10 cu. ft. of air per hour.

Circle No. 157 on Subscriber Service Card

Ferrite Circulators

Raytheon Co.'s special microwave devices operation is marketing a pair of C-band ferrite circulators for high-power applications.

The Model CCH13 has a frequency range of 5,700 to 5,900 mc. Peak power is 150 kw; average power (based on 2:1 mismatch) is 2.7 kw. Isolation is 25 db minimum for ports 2 to 1 and 20 db minimum for other paths. Maximum VSWR is 1.15.

The Model CCH14 operates in a band of 5,400 to 5,900 mc. Peak power is 1.6 mw; average power is 10 kw. Isolation is 20 db minimum; VSWR is 1.20 maximum. Insertion loss for both models is 0.5 or less.

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STRUCTURAL ANALYSIS

These positions require BS or MS degree and at least one year of appropriate experience. Specialists are needed to perform stress analysis on advanced missile and space vehicle designs and associated ground support equipment. Stress analysis tasks include the evaluation of loads and environment; the development and application of complex analysis methods to hardware designs in various environments; and the testing of vehicles and systems components in simulated flight environment for evaluation of structural adequacy.

THERMODYNAMICS

BS or MS in ME or AE and one or more years applicable experience required, to develop analytical techniques, perform theoretical studies and conduct experimental programs related to the following areas:

1. Long-term cryogenic storage including insulation systems, cryogenic stratification, tank pressurization and venting, and propellant behavior during boost and low-gravity conditions.
2. Boost and entry heating and vehicle heat protection systems, including real gas effects, reaction kinetics, flow fields and ablation phenomena.
3. Temperature control of vehicle systems and subsystems exposed to the environments of space, including thermal isolation and heat sinking effects.

GUIDANCE ANALYSIS

BS or MS EE, Physics or Applied Math with one or more years experience minimum required to:
Analyze and synthesize guidance techniques and systems for military and space vehicles, from conception to detailed formulation. This work includes the formulation of the basic guidance concept, the development of guidance equations, the definition of required measurement accuracies and the demonstration of system performance by means of digital and/or analog simulation.

This work is directed toward the guidance of vehicles in planetary orbits, re-entering planetary atmospheres, and performing lunar and interplanetary operations. Radio, optical, inertial and hybrid guidance systems, and the required mathematical treatment of the measured data are considered in these analyses.

RF AND MICROWAVE SYSTEMS

BS or MS in EE and 1 or more years' hardware experience required for work in antennas, radar transponders, propagation studies, tracking networks, and range requirements for deep space application.

AEROBALLISTICS

BS or MS in engineering or physics with one or more years experience in trajectory and performance analysis.

Position offers opportunity for both powered and orbital flight mechanics analysis associated with earth orbital, lunar and interplanetary missions.

INFORMATION SYSTEMS

Various positions are now open requiring BS, MS and PhD's in EE, AE, Physics or Applied Math, with related experience in large-scale digital computer simulations. Our projects include:

1. Development and installation of tracking analysis and engineering software support for the Apollo Instrumentation Ships Program.
2. The installation of our VESS System (Vectran Engineering Simulation System) in an important Digital Computer Laboratory.
3. Apply our advancements in GEMBET (Generalized Error Model Best Estimate of Trajectory) to major space programs and
4. Continue our basic research involving pattern recognition and prediction, artificial intelligence and the general advancement of information and systems techniques.

SCIENTIFIC PROGRAMMING

Positions are available for engineering and scientific programmers with a minimum of a BS degree and two years' experience in symbolic programming for large-scale digital computers. Assignments will involve engineering and scientific programming applications. The tasks include real-time program organization, multichannel input/output for peripheral equipment, utility and diagnostic routines, data simulation, and programs for analysis and synthesis of the tracking and navigation data. Equipment utilized is an IBM 7094-44 directly coupled system.

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names in the news

BAWER

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BRINSFIELD

BABEAUX

Leon I. Bawer: Promoted to vice president of General RF Fittings, Inc. He will be responsible for overall marketing and general sales of the company's line of precision coaxial connectors and microwave components.

Howard J. Warnken: Elected vice president of operations for the Archbald, Poughkeepsie and Transicoil divisions of Weston Instruments, Inc. He will continue as general manager of Weston-Archbald, a position he has held for six years.

Shirley D. Brinsfield: Elected vice president of the Curtiss-Wright Corp. He was promoted to his new post as a corporate officer from the position of general manager and president of the company's electronics division in East Paterson, N.J.

Albert G. Babeaux: Named president and chief executive officer of the Birtcher Corp. He was a co-founder of the company.

William T. Donovan: Appointed director of industrial relations for Philco Corp.'s communications and electronics division in Philadelphia.

Francis M. Whitacre: Appointed director of engineering, industrial products of the Liquidometer Corp. He is a former professor of organic chemistry at the Case Institute of Technology.

Thomas M. Blake: Elevated to the position of chairman of the board of Littelfuse, Inc. **Jack D. Hughes** was elected president.

W. Stanton Halverson, Jr.: Elected chairman of the board of Air-Shields, Inc. He was formerly president of the medical sciences division of Litton Industries and is currently president of National Aeronautical Corp.

Erwin David: Appointed senior applications engineer of Philbrick Researches, Inc. He will be responsible for all aspects of the company's applications engineering functions.

Charles G. Fouts: Appointed director of sales of Cinch-Graphik, division of United-Carr, Inc. He will be responsible for the overall marketing efforts of Cinch-Graphik's line of etched circuitry.

Ronald N. Campbell: Elected a director of the Westinghouse Electric Corp. **George L. Wilcox** has also been elected director of the company. Both are executive vice presidents.

Dr. Edward C. Sweeny: Elected president of the National Aeronautic Association for the year 1966. He is a member of the Subversive Activities Control Board and has been re-appointed by President Johnson for a term that will not expire until 1970.

William S. Floyd and **Geoffrey Winkler:** Elected vice presidents of Huggins Laboratories, Inc. Floyd is secretary-treasurer, and Winkler is director of operations.

Roland M. Bixler: Elected to the board of directors of C & K Components, Inc. He is president of J-B-T Instruments, Inc., also president of the Woodbridge Bank & Trust Co.

Melvin Barmat: Appointed general manager of Fairchild Hiller's Electronics and Information Systems Div. Previously, he was associated with General Instruments Corp. where he established and managed that company's Thermoelectric Div.

Robert E. Chandos: Joined the technical staff of Electro Optical Industries, Inc. He will be responsible for the design and development of specialized electro-optical systems and automatic production check-out equipment.

Warren R. Hughes: Elected a member of the board of directors of Zep Aero. He is president of Intercontinental Public Relations, Inc.

James P. Minogue: Appointed program manager of Huyck Systems Co. He will be responsible for directing, planning, and co-ordinating all phases of the company's major programs.

Robert W. Downey: Joined the staff of the Center for Naval Analyses of the Franklin Institute. He has been assigned to the Naval Warfare Analysis Group.

Heinz Gruner: Appointed research scientist in the R&D Div. at Bausch & Lomb.

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Seminar on "Effect of Temperature on Metals," sponsored by the American Society of Mechanical Engineers, Chicago, Nov. 10.

18th Annual Conference on Engineering in Medicine & Biology, sponsored by the Institute of Electrical & Electronics Engineers, Instrument Society of America, Sheraton Hotel and University of Pennsylvania, Philadelphia, Nov. 10-11.

Nuclear Spin-Parity Conference, co-sponsored by the Oak Ridge National Laboratory and American Physical Society, Gatlinburg, Tenn., Nov. 11-13.

Fall National Meeting of the Society of Aerospace Material & Process Engineers, sponsored by the Society of Aerospace Material and Process Engineers, Biltmore Hotel, Dayton, Ohio, Nov. 15-17.

1965 Atomic Fair and Winter Meeting of the American Nuclear Society, sponsored by the American Nuclear Society, Sheraton Park Hotel, Washington, D.C., Nov. 15-18.

International Congress on Air Technology, sponsored by the Valley Education and Research Foundation and the Arkansas Industrial Development Commission, Hot Springs National Park, Ark., Nov. 15-18.

Fourth Annual Symposium on the Physics of Failure in Electronics, co-sponsored by Rome Air Development Center, Griffiss Air Force Base, and IIT Research Institute, Grover M. Hermann Hall, Illinois Institute of Technology, Chicago, Nov. 16-18.

National Conference for Space Age Facilities, sponsored by the Florida chapters of the Society of Civil Engineers, Aerospace Transport Div., Society of American Military Engineers, Canaveral Council of Technical Societies, and the Florida Engineering Society, Ramada Inn, Cocoa Beach, Fla., Nov. 17-19.

International Conference on Tropical Oceanography, sponsored by the Institute of Marine Science, Institute of Marine Science, Miami, Nov. 17-24.

1965 Fall Computer Conference, Convention Center, Las Vegas, Nev., Nov. 30-Dec. 2.

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Questions and Answers

THE NEED FOR INCREASED ATTENTION by this industry to the requirements of limited warfare became evident several years ago, long before the war in Viet-Nam reached its present stage of escalation.

Among others, Dr. Eugene Fubini, then deputy director of Defense Research and Engineering, urged aerospace scientists and engineers to drop their eyes from the stars—to take, from time to time, a look at the mud under their feet. Other industry leaders pointed out the potential of the application of advanced technology to the age-old problems of infantrymen in face-to-face confrontation with the enemy.

The industry has not been overly quick to respond. There were some good reasons for this. As Dr. Ruben F. Mettler, the far-sighted president of TRW Systems, pointed out two years ago, the missile/space industry was none too familiar with the environment in which limited-warfare weapons must function. It is one thing for engineers to build an ICBM which will function in the cotton-wool environment of a silo which they also build. It is an entirely different proposition to build something which will work reliably in the dirt, dampness and rot of a jungle battlefield in the hands of a young soldier who holds no engineering degree. It takes time to learn about these new requirements. Even so, the industry response seemed a long time in coming.

It is encouraging therefore to note that the industry now appears to be wholeheartedly engaged in a massive effort to tackle the problems of tactical warfare. One evidence of this was the recent exhibit in Washington of the Association of the United States Army. Companies whose names are far more familiar in connection with space probes and intercontinental missiles were on hand in greater numbers than ever before. Many of the exhibits called attention to engineering efforts to solve the communications, transportation and weaponry problems of the infantry soldier. Many of these projects, it should be noted, are company-funded.

Firms familiar with the landing gear required of huge transport aircraft for soft-field landings are applying their knowledge to the problems of getting Army rolling stock through mucky terrain. Organizations which have solved the antenna problems of communicating across the reaches of space are taking a look at the needs of beleaguered outposts in the Viet-Nam jungle.

Another facet of this increasing attention to limited warfare was highlighted in a recent speech to the National Space Club by Gen. Bernard A. Schriever of Air Force Systems Command, who said:

"These efforts are obviously of crucial importance. They help save the lives of our men in combat and they help us attain our national objectives more effectively. The fact that many relatively small projects are involved, rather than a few large-scale programs, should not be allowed to obscure the extent and importance of our work in this area."

Gen. Schriever noted that the area of tactical warfare is one of the few today in which there are no financial restrictions on research and development.

"During the last three fiscal years," Gen. Schriever said, "the research, development, test and evaluation (RDT&E) funding for lower-spectrum warfare has risen rapidly after many years of relatively little emphasis. At the present time, Systems Command has hundreds of programs, projects and tasks directed toward improving Air Force limited-war and special-air-warfare capabilities. Many of these programs are providing near-term solutions to current operational problems encountered in Southeast Asia. In fact, such near-term requirements are an increasing part of our task."

Systems Command welcomes industry help in solving these problems. In view of this, it is worthwhile taking a look at the procedures the Air Force has set up for providing quick reaction to requirements from the field.

FIRST, THERE IS WHAT IS KNOWN as SEAOR, the Southeast Asia Operational Requirement procedure. Under this, the Second Air Division in Viet-Nam, when it identifies an operational need to its headquarters in the Pacific, at the same time provides the same statement of need by TWX to Air Force headquarters, Air Force Systems Command, the Tactical Air Command and the Air Force Logistics Command. If PACAF headquarters concurs in the need, AFSC and TAC simultaneously prepare their best preliminary estimates on a solution. If USAF headquarters agrees, the fix gets under way.

As a second step, Systems Command has designated a deputy for Limited War at ASD to serve as a single focal point with broad and detailed knowledge of the R&D activities in this area. Gen Schriever has appointed Brig. Gen. Henry B. Kucheman, Jr., to this post. It is of significant interest that he comes from the Space Systems Division of AFSC.

The third element in this quick-response network is of particular interest to industry. This is Project 1559. Under this project, Systems Command can buy and test hardware concepts proposed by industry. Although the project cannot fund development or production, it can acquire prototypes in order to test sample quantities of promising end-items.

Industry proposals are receiving the same ready interest from the Army and Navy. The services have established the procedures, funding is available and it is heartening, as we said, to find industry response growing. Answers cannot come too soon.

Official releases on Viet-Nam sometimes tend to obscure the need for urgent solutions. As an example, Department of Defense reported at a recent briefing that of 116 aircraft lost over North Viet-Nam, only six were shot down by surface-to-air missiles.

This may be literally true, but the fact is that most of the other 110 aircraft were brought down due to the presence of SAM installations which forced them down within reach of conventional anti-aircraft fire.

The faster this industry can bring its scientific and engineering talents to bear on such problems, the quicker the unpleasant mess in Southeast Asia will be resolved.

William J. Coughlin

System engineering for airborne weapon systems

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Responsibilities: The determination of detailed functional design requirements for complex Airborne Weapon Control Systems; system design per customer requirements; theoretical analysis of system performance and liaison assistance to engineering departments to develop equipment to fulfill system requirements.

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Education: B.S. in E.E., M.E. or Physics. Applicants should be articulate in writing and communication as related to their responsibilities. U. S. citizenship required.

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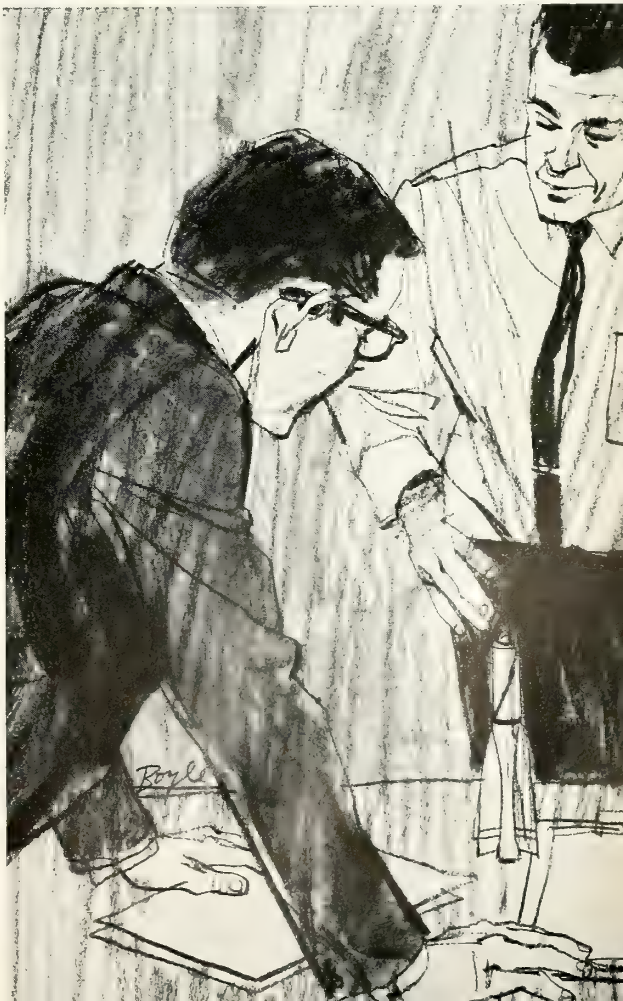
Education: B.S. in E.E., M.E. or Physics. Articulate in communications. U.S. citizenship required.



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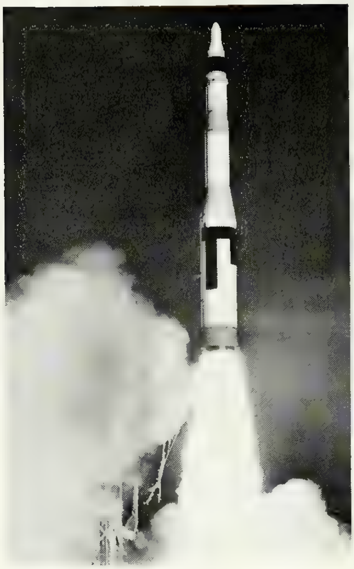

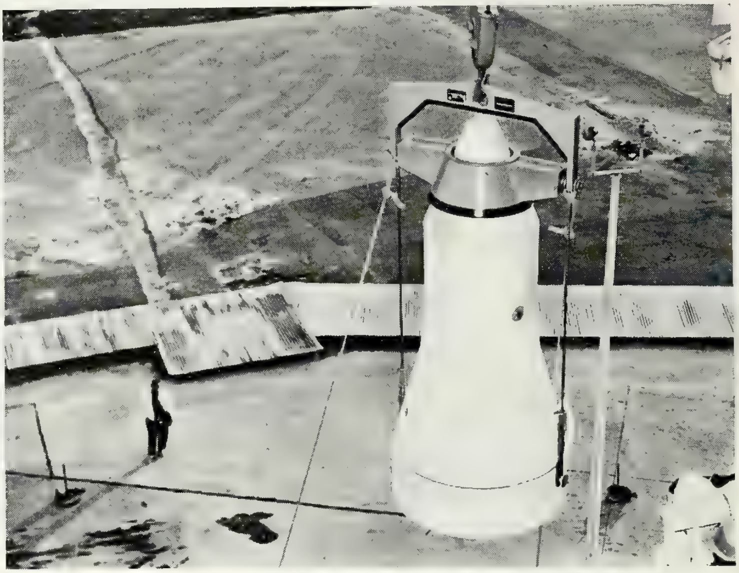

One major challenge of the Minuteman Program: the need for concurrency. The ability to begin operational production before the research and development phase has ended. Avco/RAD—a member of the Air Force team of Associate Contractors—has had prime responsibility for the development of the re-entry system. Our assignment: to give the Minuteman weapons system maximum flexibility through a continual evolution of re-entry vehicles: the Mark 5, Mark 11, and Mark 11A. Each being developed, tested, and introduced into the system with complete compatability. At Avco/RAD, advanced re-entry systems undergo constant study, to assure that our military arsenal will not become obsolete. This approach to re-entry systems development requires capabilities in systems analysis, research, engineering, manufacturing, flight testing, and overall program management. Avco/RAD puts all these capabilities "under one roof."

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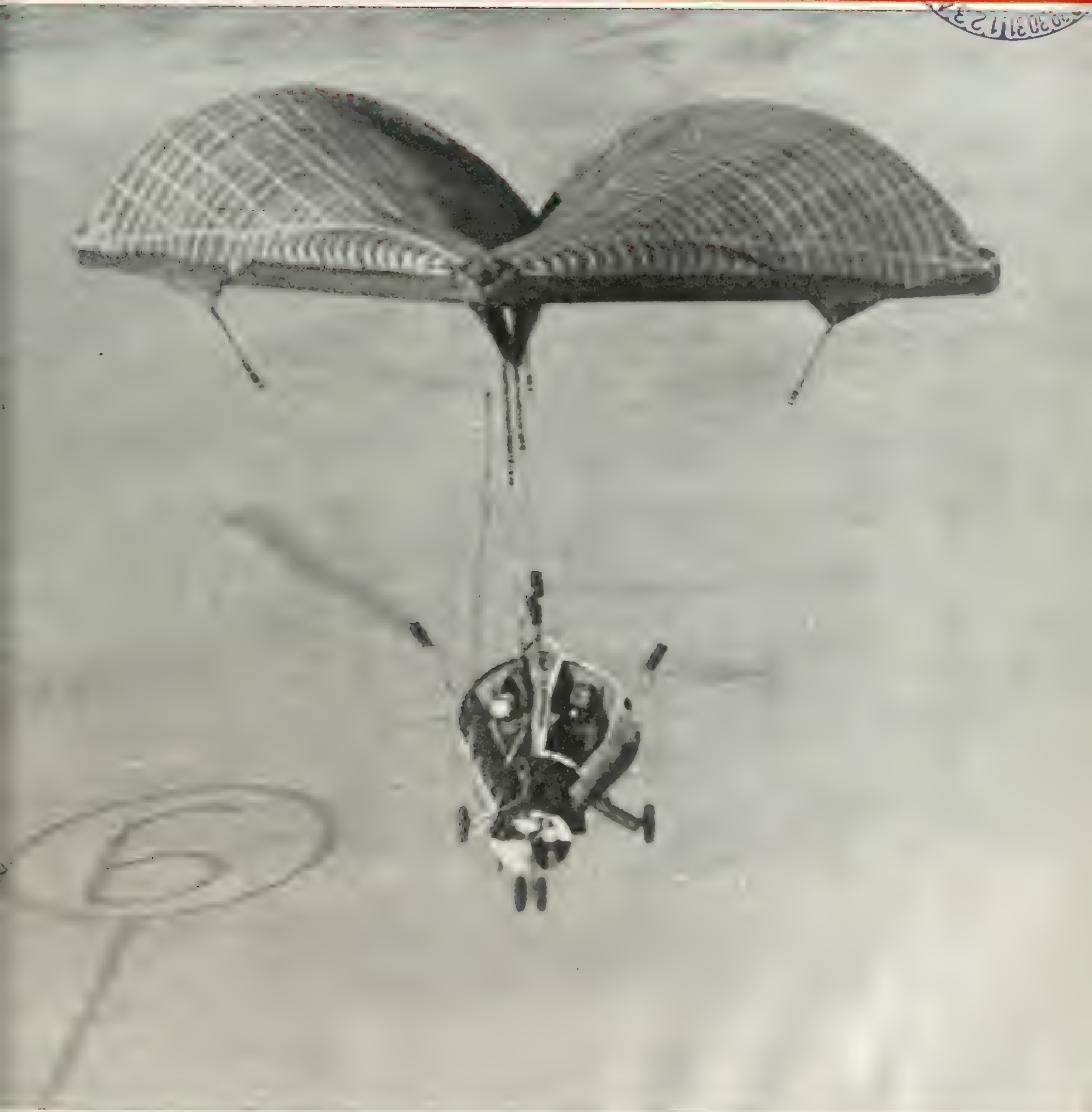

NAA Flexible-Wing Recovery System in Flight

Orbital Weapons Delivery Questio

Aerospace Stocks Continue Surge

Boron Filament Plant Being Built

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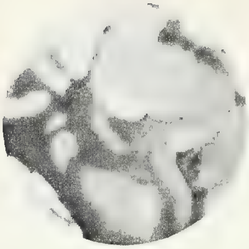
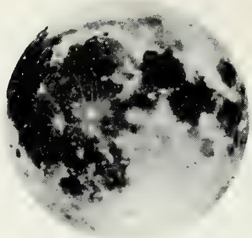


Tune in
on buses
to Mars,

Monitor
MOL,



Pick up
heartbeats
on the way
to the Moon,

Relax
on the
beaches of
Florida…

and
become one
of the
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space pros
while
doing it.

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at McDonnell…"man-in-the-loop" simulation of Gemini missions tests space flight control concepts, procedures

The McDonnell Automation Center, a division of McDonnell Aircraft Corporation, recently installed a CONTROL DATA® 3200 hybrid system to assist in the design of spacecraft and aircraft. One of the system's major uses is "man-in-the-loop" simulation of the Gemini missions. Astronauts and McDonnell engineers use the system to simulate the operation of control systems and the on-board computer. The simulator, utilizing live instrumentation, produces electronically the visual displays and instrumentation responses the spacecraft will encounter in flight — from lift-off through orbit and rendezvous to re-entry.

It is thought that the growing requirements of the Gemini program will require extensive use of the 3200 for some time to come. However, the system's great power and flexibility will permit multiprogramming — other Automation Center jobs (both divisional and customer) will be processed by the system even while the computer is busy with hybrid simulation projects planned for it.

Designing computer systems to satisfy specific project needs is a Control Data Corporation specialty. Whether it be a hybrid system such as McDonnell's or a real-time system like that operated by the Air Force at Cape Kennedy, your program is assured the ultimate in quality and reliability. For details on special systems contact our representative; or our Minneapolis address direct. Dept. M-115.

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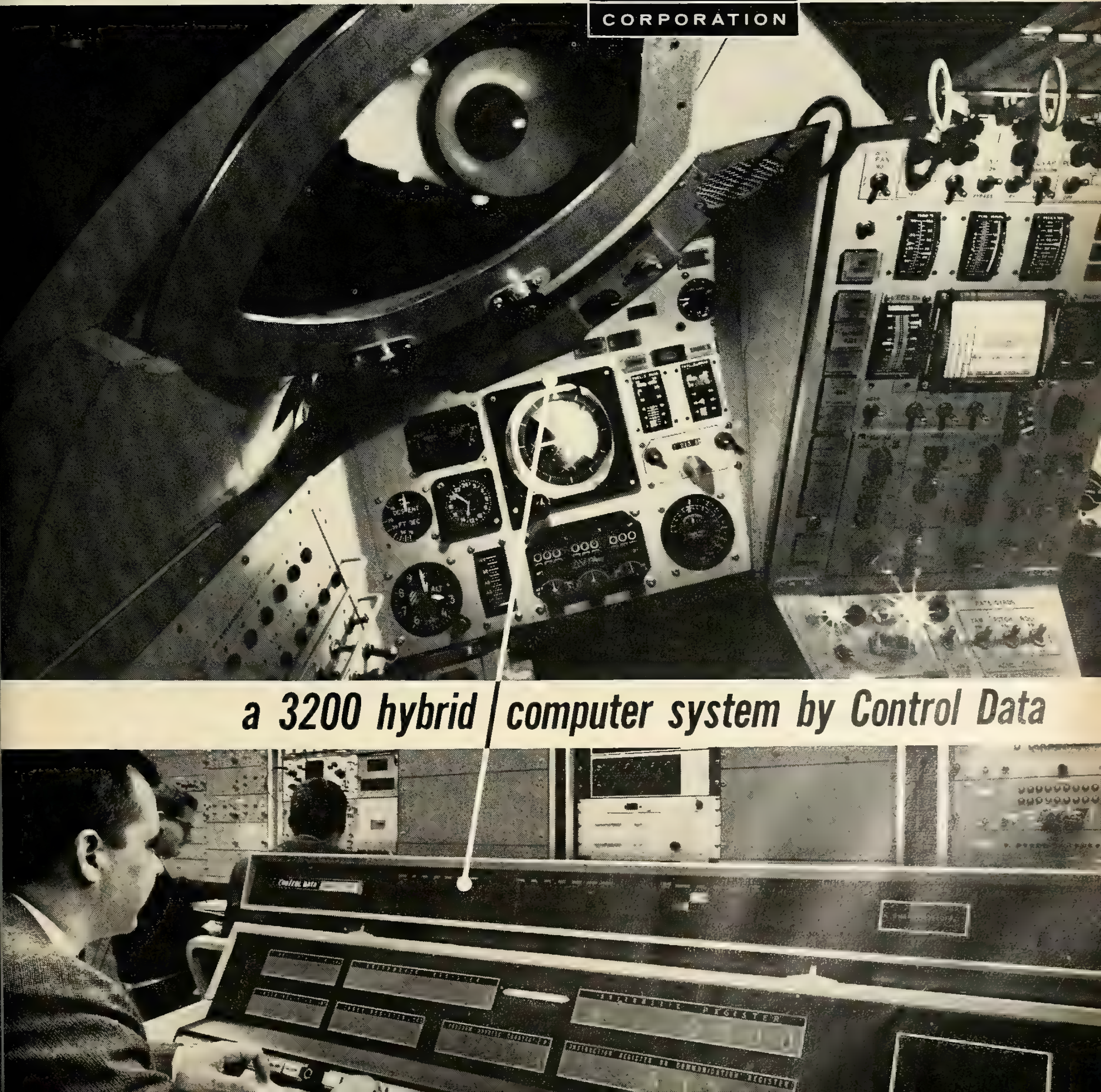

HOW TO RUN A NUCLEAR OBSTACLE COURSE

A recent breakthrough in materials for hardened heat shields will help ballistic vehicles penetrate harsh environments — ranging from the shock of radiation to fireball traverse.

Lockheed has developed a method of producing composite materials possessing thermal efficiency and structural strength superior to state-of-the-art approaches. It is based on winding and inorganically bonding various types of filaments such as carbon, silica and graphite.

The Lockheed composites offer many advantages. They are tailored to different environments through an interdisciplinary effort involving weapons effects, system design and other key technologies. Example: a gradual transition from carbon filaments on the surface of the shield to silica in the mid-portion increases strength, lowers thermal conductivity. Result: stronger, lighter hardened heat shields – and optimu vehicle design.

Materials such as these are just o measure of the technological co petence of Lockheed: a corporatio dedicated to the conquest of ne worlds through innovation.

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THE WEEKLY OF ADVANCED TECHNOLOGY

Volume 17, Number 20 November 15, 1965

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THE COVER

Exclusive photo of North American paraglider used as recovery system for Gemini-type capsule shows pilot in left position, dummy at right in recent test flight. NASA is still studying the inflatable wing concept for maneuverable recovery of manned spacecraft. See story, p. 12.

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letters

Who's on First?

To the Editor:

Taking up the suggestion that Mr. A. W. Jones advanced in his letter in the Oct. 25 issue, I should like to emphasize the importance of using one consistent system in reporting data. Scientific and technological publications can exert a very useful influence.

Astronomic data are available only in metric measure. Accurate dates for the Moon's orbit are known only in kilometers. The mass of the Moon has never been published in pounds—neither in mass-pounds, which would be a very uncommon unit, nor in slugs, a devil in the engineer's calculations because it is based on the foot. No, only in kilograms or perhaps megagrams, also called metric tons. All these calculations are being made in the metric system.

At which stage the transition from the international, the metric, system is made to the conventional British system I do not know, probably at the layout designer's desk. The detail designers and the shop personnel know only inches. I have a suspicion that errors can sneak in here.

A periodical of advanced technology such as yours should not mix the systems unnecessarily. On page 26 of the Oct. 25 issue, temperatures are reported in Degree Kelvin, according to the metric system. But look at page 12—orbital data for Russian communication satellite *Molniya* are reported as 24,855 mi. and 310 mi. When I convert these figures to metric values, I find 40,000 kilometers and 500 km.

Three questions arise in my mind. First: the original Russian report obviously has given the figure as approximate values, which is justified for the purpose. Your figures in miles suggest much higher accuracy than is actually warranted. Second: I trust that I judged well in the aforementioned case by taking your miles as statute miles. But turn back to page 10. Your report on *Titan III* uses nautical miles. At this point I become critical and the third question arises: The reported values for the Russian satellite describe a highly eccentric orbit. Is this practical for a communication satellite or has a decimal point slipped? When they later give a strong boost at the apogee, much more than a mere correction, a circular orbit at 40,000 km distance would achieve one revolution in just 24 hours. Would you elaborate on this?

Dr. Friedrich K. Bielitz
Lycoming Division
Avco Corporation
Stratford, Conn.

Communication satellites, other than synchronous types, are likely to have elliptical orbits—prime examples are the Relays and Telstar. The Russians deliberately put their recent Molniya into its highly elliptical orbit, according to Izvestia, so that during most of each orbit the satellite is over the Northern Hemisphere, providing a communications link between all parts of the USSR. As to Dr. Bielitz's comments on mixed measurement systems, we agree completely. We have been captives of this practice, along with most publications, but we hope someday to do something about it.—Ed.

Information Pleased

To the Editor:

Your Nov. 1 article entitled "National Information Program Impends" was most interesting and informative.

I read your publication avidly each week and enjoy it a great deal. Keep up the good work!

Donald H. Culver
Supervisor
Publications Operation
Nuclear Materials and
Propulsion Operation
General Electric Company
Cincinnati, Ohio

Dandridge Cole's Legacy

To the Editor:

On Oct. 29, Dandridge Cole, 44, Space Programs Analyst for GE's MSVD, died suddenly of a coronary. Besides leaving his wife and six young children, Dan left a legacy of books and articles which encompass a set of guidelines for us to follow if we wish to establish a truly comprehensive national space program beyond *Apollo*.

As one of that small band of "hurriers" and "needlers" of NASA and our space leadership, Dan clearly saw the need for key decisions to be made *now* at the White House/NASA level to give us a follow-on program for the 1970-80 time period. As the nation's foremost authority on the astronautics of manned and unmanned flight to the asteroids in the next decade, Dan went around the country as a missionary to help sell this worthwhile space goal to NASA officials. In two undelivered papers written just before his death, Dan proposed a modified *Mariner* flight to the planetoid Toro, which will come within 4,000,000 miles of the Earth in 1968.

But his real, lasting legacy may lie in his philosophy of spaceflight—something in which we have been deficient in America since *Sputnik I*. In a co-authored book, Islands in Space, published last year, Dan summed up his feelings about the cosmos when he wrote:

"Space is a sea without end, which washes on countless strange and exotic shores; where the conceivable forms of the living and the dead are greatly outnumbered by the inconceivable; where the known is lost in the unknown; where new dangers hide in undiscovered shadows and in unimagined forms; where new goals can challenge and new beauty and wonder can inspire the spirits of all people—for all time."

Don Cox
Director
Philadelphia Science Center
Philadelphia, Pa.

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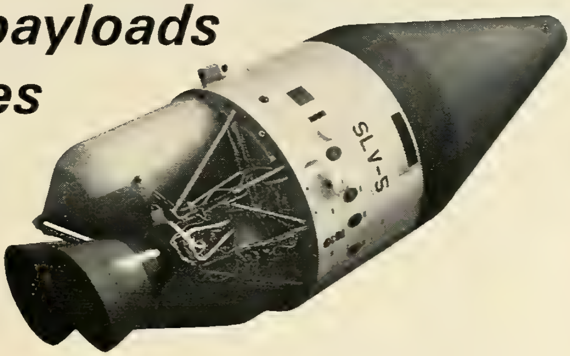
that can stop, start, turn in orbit,
move a heavy payload
from one orbit to another,
put multiple payloads
multiple places
with pinpoint
accuracy.*



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TRW SYSTEMS

The Countdown

WASHINGTON

'Big-Q,' Small Program

An in-house program aimed at improving air-to-air missile capabilities, known as AIM-X or "Big-Q," is near completion at the Air Force Research and Technology Div. Project is said to be directed at use of off-the-shelf technology to improve missile system components. This could indicate an attempt by the Air Force to introduce more simplicity and reliability into some of its most sophisticated weapons. Program, which includes some flight testing, is not slanted at development of a new missile system.

TOW Gets Nod for AAFSS

Army's *TOW* anti-tank, wire-guided missile system is the only one now definitely scheduled to see service aboard the new Advanced Aerial Fire Support System, should the Army decide to put this new helicopter weapons platform into full-scale production. Lockheed, winner of a competition for AAFSS prototype development, will supply 10 test vehicles. No decisions have been reached yet on other AAFSS weapons. Beyond *TOW*, Army is looking at anti-tank missiles using electro-optical guidance techniques.

RL-10 Seen for Kick Stage

NASA officials now believe that addition of fluorine to the RL-10 engine appears to be the best bet for a propulsion system for the proposed planetary kick stage. New rocket stage is expected to go to project definition in FY '67 if missions are approved for the 1972 time period.

Titan III-C Shelter Bids Ready

Bids are to be opened today on an environmental shelter at Cape Kennedy's Complex 40 for final preflight checkout of *Titan III-C* payloads. Shelter, to cost some $450,000 and to be completed in April, 1966, could be important to *Manned Orbiting Laboratory* operations.

IQSY Launch Set at Wallops

NASA has scheduled launch of the IQSY (International Quiet Sun Year) satellite for no earlier than Nov. 17 from Wallops Island. Satellite will measure solar storm and solar ray activity. Booster is a *Scout*.

Deep-Submergence Bids Sought

Bidders' conference will be held Nov. 23 on the contract for design and development of a prototype deep-submergence rescue vehicle for Navy's Special Projects Office. Requests for Proposals have been issued to 11 companies. Bids are due Dec. 23. Contract will provide eight months for completion of advanced design work and 18 months for fabrication of the prototype. Bids will cover two designs—a ring-tail stabilized vehicle and an alternate design for a tandem propeller-type vehicle.

Phoenix Fix Progress Reported

Navy's new *Phoenix* air-to-air missile and fire control system, plagued by cost overruns and technical difficulties, now is said to be back on the right track. Optimistic reports on *Phoenix* came from high-level U.S. officials who also reiterated their faith in its carrier, the F-111B. Concerning the Navy F-111, these reports say weight reduction is continuing, engine power is increasing, and lift/drag figures are better than anticipated.

Apollo Suit Freeze Set

Manned Spacecraft Center now believes it can freeze *Apollo* spacesuit design early next year, with flight qualification tests to begin on the *Apollo* 207 mission next fall. MSC recently selected International Latex Corp. to make the suits and Hamilton Standard Div. of United Aircraft Corp. to develop a portable life-support system to be used with them.

Who's That Down There?

Navy has started research and development on an interim ASW Classification Analysis Center (ASCAC) designed to provide rapid and accurate identification of contacts made by various ASW patrol units. Northrop's Ventura Div. holds a contract for more than $1 million for the work, which will be directed by NADC at Johnsville, Pa.

INDUSTRY

Marquardt Delivers New Missile Ramjets

Marquardt Corp. has delivered the first five flight units of a new, larger-diameter ramjet engine for the *Redhead/Roadrunner* target missile. The 19-in.-dia. engine is 2½ in. wider than the engine already in service. It is designed to extend the missile's capability beyond Mach 2 and to altitudes of 60,000 ft.

Advanced Athena Is Studied

Atlantic Research Corp.'s proposal for an advanced *Athena* vehicle with a payload of about 450 lbs. is under evaluation by the Air Force. Vehicle's present payload is about 50 lbs. Possibility of shifting *Athena* launch site to the state of Washington to extend the range also is under consideration. *Athena* now is fired into the White Sands (N.M.) Missile Range from Green River, Utah.

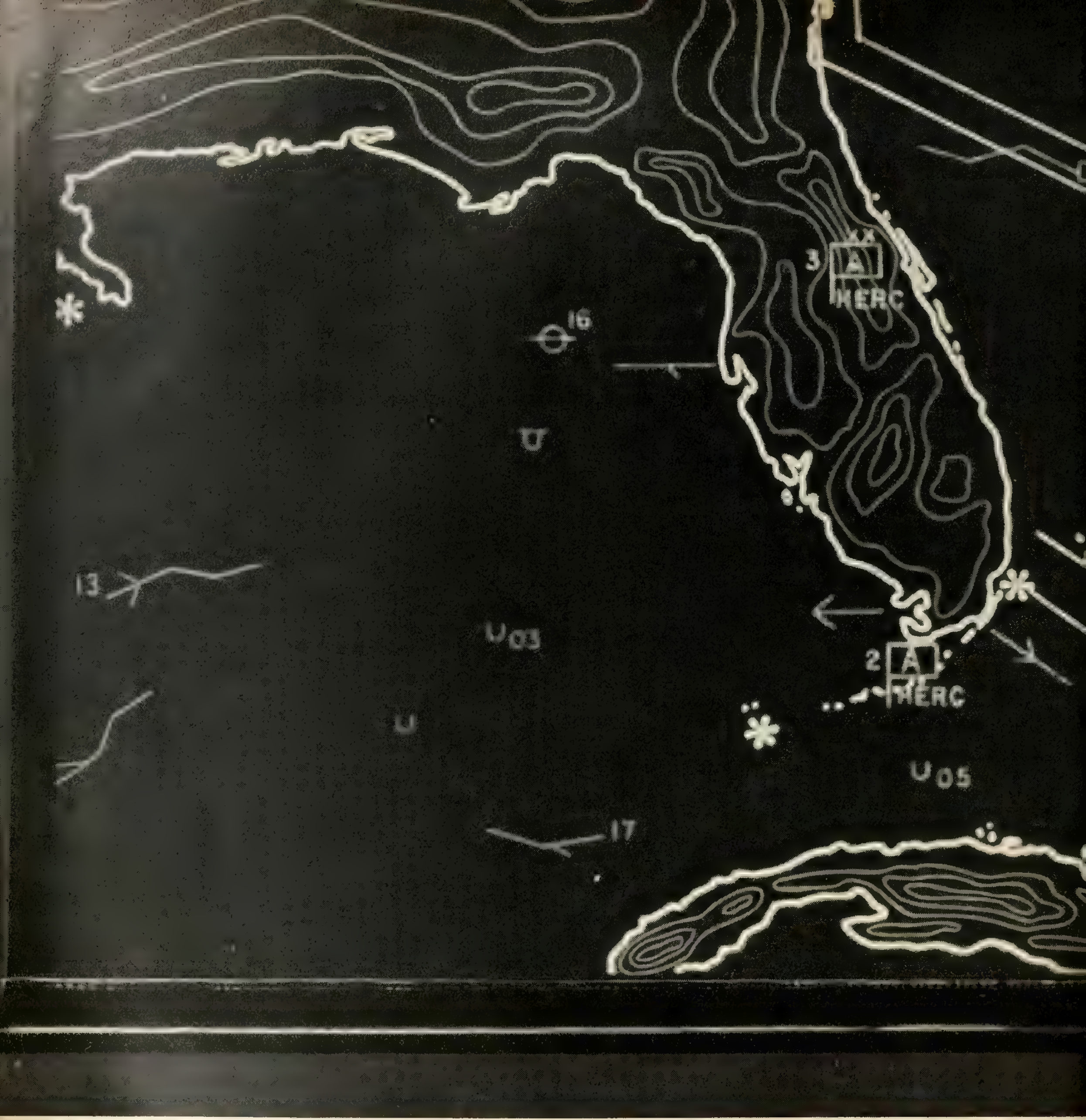
David Clark To Build MOL Suit

Contract for research and development for a pressure suit for the *Manned Orbiting Laboratory* is being negotiated with the David Clark Co. by Air Force's Space Systems Div. David Clark is NASA's contractor of the intra- and extra-vehicular *Gemini* suits.

INTERNATIONAL

NASA Signs Agreement with Argentina

NASA and Argentina have signed an agreement calling for launching of four sounding rockets to study the ionosphere. Two daytime and two nighttime launches of the *Nike-Apache* rockets are planned from the Chamical, Argentina, range to measure electron density and temperature.



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Vigicon's picture of its own future is exceedingly bright.

NORTHROP

Gemini Flights Set

Launch of the *Gemini 7* manned spacecraft is now scheduled for Dec. 4, to be followed by the *Gemini 6* launch on Dec. 13.

According to NASA, *GT-6* astronauts Walter M. Schirra and Thomas P. Stafford will rendezvous their spacecraft with *GT-7* astronauts Frank Borman and James A. Lovell, Jr., during the fourth revolution. They will also station-keep with the *Gemini 7* spacecraft "for a period of time." (M/R, Nov. 8, p. 14).

The space agency has also named the crew for the *Gemini 9* mission, officially scheduled for the third quarter of 1966. Elliot M. See, Jr., and Charles A. Bassett II were named *GT-9* primary crew, with Thomas P. Stafford and Eugene A. Cernan the back-up crew. Informed sources have indicated that the 2-to-3-day rendezvous and docking mission may take place as early as April.

Strike Could Hit Gemini 7

Wildcat strike of McDonnell Aircraft Corp. employees may yet interfere with the upcoming *Gemini 7* mission, now scheduled to start no earlier than Dec. 4.

Union representatives have notified the firm that if their grievances are not settled by Nov. 19, a general strike may be called. This could spread to Cape Kennedy to halt launch vehicle/spacecraft checkout.

Bendix Gets $37 M for Talos

The Navy has awarded a three-year, $37-million contract for production of 470 *Talos* missiles to Bendix Corp.'s Mishawaka Div.

Agena Failure 'Diagnosed'

A NASA-Air Force flight safety review board convened to pinpoint the failure of the modified *Agena* vehicle in last month's abortive *GTA-6* rendezvous mission has dissolved without conclusive results.

Aerospace Corp. and Lockheed Aircraft Corp., *Agena* contractor, agree that the most probable cause of failure was a "hard start" of the *Agena* primary propulsion system. This unofficial finding refers to a system change in the standard *Agena* vehicle designed to increase the restart ability from two to five times. The original solid start system was replaced by small liquid-propellant start tanks—designed to admit propellant to the gas generator system, which, in turn, bootstrap the main engine.

The result, says the official release, is that the difference between ground tests and the start in space may be that the amount of fuel pre-injected and the degree of vacuum existing in the thrust chamber during flight were somewhat different.

Industry Briefings Announced

The Dept. of Defense has announced the following schedule of unclassified regional Advanced Planning Briefings for Industry: Boston, Mar. 3-4; Atlanta, Mar. 9-10; St. Louis, Mar. 16-17; San Francisco, April 12-13; and Washington, April 27-28.

NASA Lets Computer Pact

NASA will conduct competitive negotiations with Telecomputing Services, Inc., and LTV Range System Div. for a one-year contract to provide computer support services at Michoud Assembly Facility.

The cost-plus-award-fee contract is expected to exceed $1.5 million. Provisions are included for three one-year renewals. The award will also cover support services at the Mississippi Test Facility.

Flexible Wing Tests End

North American Aviation's Space & Information Systems Div. has completed its NASA-sponsored flexible wing flight program, successfully demonstrating manned flight and landing (see cover).

Next step, which would be building and qualifying such a system for controlled recovery of manned spacecraft, is up to NASA.

Officials at S&ID are preparing a final report for the Manned Spacecraft Center. Bert Witte, director of flexible wing systems, told MISSILES AND ROCKETS that, "essentially, we met all program objectives." Tests ended Nov. 5.

Pilots reported good maneuverability and quick response, and they showed ability to fly and land the vehicles used in the tests in predetermined landing spots. Wind penetration—flying against the wind, necessary for adequate maneuverability for landing—was reported to be good.

Three vehicles were used, one radio-controlled, the others manned. The two manned vehicles, each equipped with full-scale *Gemini*-type capsules, consisted of an inflatable wing with keel and leading edges 31-ft. long connected with flexible Fortrel material. For manned flights, the vehicles were towed to 10,000 ft. by an S-61 helicopter and released.

Twelve flights were made with the manned vehicles. NAA had been scheduled to fly two men in the capsules, but used a pilot and dummy instead. Speed of the craft was between 35 and 50 knots. Although maximum turn rates were not attained, pilots completed 400-ft. circles.

Shots of the Week

Explorer XXIX (designated *GEOS-A* before launch), was sent aloft Nov. 6 by the first *Improved Delta* launch vehicle to be used, but the payload missed the orbit intended by Johns Hopkins University's Applied Physics Lab, designer and builder of the geodetic satellite.

Overcast conditions at Cape Kennedy caused the vehicle's ground guidance system to lose its lock on the *Delta* 30 seconds after launch. The second-stage velocity cutoff system, which was riding open loop, thus remained open loop, and the second stage functioned to burnout, putting the satellite into a higher orbit.

A NASA official said, however, that the higher orbit presented only a "minor annoyance." *Explorer XXIX* has an apogee of 1,414 statute mi., a perigee of 960 mi., an inclination of 59° and a period of 120 min. The orbit was to have been 1,058/644 mi.

- The Air Force's Air Proving Ground Center at Eglin AFB, Fla., launched three high-altitude research rockets in conjunction with International Quiet Sun Year tests conducted in cooperation with the Air Force Cambridge Laboratory Nov. 2-3. An *Exos* rocket carrying a 66-lb. payload and a *Sparrow-Arcas* with a chemical payload were launched Nov. 2; a *Nike-Cajun* was fired Nov. 3 to measure the density and temperature of the atmosphere. A total of 26 shots is planned in the IQSY series.
- An air-to-surface *Hound Dog* missile was successfully fired from an Air Force B-52 bomber over Green River, Utah, to a target area in the White Sands Missile Range, N.M., Nov. 3.
- The Air Force successfully launched an *Athena* test vehicle from Green River, Utah, on Nov. 5. The re-

entry vehicle impacted on the White Sands Missile Range, N.M. Basic re-entry measurements were accomplished by *ABRES* instrumentation.

- The Soviet Union launched the 95th *Cosmos* satellite Nov. 4.
- The Air Force successfully launched a *Minuteman II ICBM* from Vandenberg AFB, Calif., Nov. 9.

SNAP-10A Shutdown Probed

The Atomic Energy Commission says that the most probable cause of the premature shutdown of the SNAP-10A nuclear reactor powering the *Snapshot* satellite was the failure of a voltage regulator in the system.

Snapshot was launched last April 3, but ceased operation 43 days later.

The analysis indicates that the loss of voltage regulation within the satellite electrical system led to sequential failure of several major components. Cause of the regulator malfunction, however, cannot be determined.

Hughes Gets Satellites Award

The Federal Communications Commission has authorized construction of four synchronous communications satellites for possible use with the *Apollo* program (M/R, Nov. 8, p. 13).

Hughes Aircraft Co. will build the satellites under an $11.7-million contract from Communications Satellite Corp.

Fubini Replacement Expected

DOD is expected to name a new deputy director for defense research and engineering before the end of the year.

Filling of the post, formerly held by Dr. Eugene Fubini, will virtually complete the DDR&E reorganization started in September (M/R, Sept. 13, p. 14). John W. Klotz has been named assistant director (tactical control and surveillance systems). He formerly worked for the deputy director for electronics and information systems.

Crawler Fix Slipping to '66

Contrary to earlier official indications that the *Saturn V-Apollo* crawler-transporter bearings fix would be effected by Dec. 1 (M/R, Nov. 8, p. 10), an authoritative source now sees completion of the repair slipping into next year.

Don Buchanan, project engineer for prime contractor Marion Power Shovel Co., told M/R that, because of labor problems (M/R, Oct. 4, p. 15), repair work has just begun.

HERCULES

Safe Way to the Surface

Present-day deep-running submarines have brought an increased need for an effective method of escape in critical situations. Long concerned with this problem, the survival system branch of the U.S. Naval Applied Science Laboratory joined Hercules engineers in developing an escape capsule capable of withstanding severe pressures during ascent.

Pioneers in development of rocket motor cases made from Spiralloy® filament-wound glass fibers, Hercules utilized the same material in the escape capsule shown here. The material when properly formed provides a structure lighter than aluminum and stronger than steel.

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Soviet Claim Could Spur Space Track

Defense experts still discount military effectiveness of nuclear weapons in orbit; one challenge could involve SAC aircraft

by **Michael Getler**

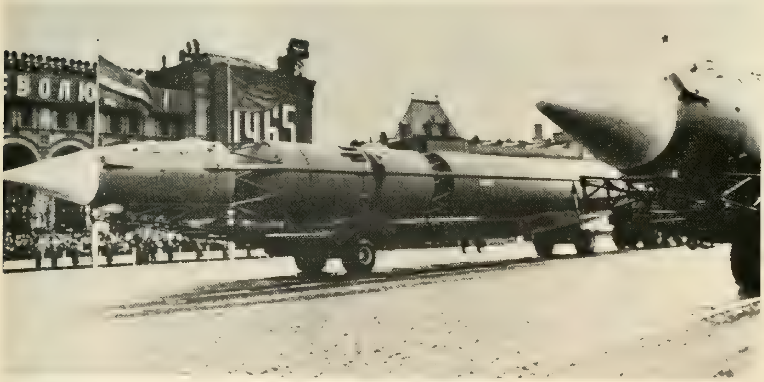
DESPITE NEW SOVIET claims of "orbital missiles whose warheads can deliver their blow on the first or any other loop around the Earth," top U.S. defense analysts still regard these weapons as more effective in a parade than in orbit.

Although an analysis of the most recent Soviet hardware display, held during the Nov. 7 Moscow parade in observance of the 1917 revolution, has yet to be completed, there is no conflict between high-level military or civilian DOD judgments on this basic point.

U.S. officials have said in the past that delivery of nuclear weapons from orbit is highly inefficient from a military point of view. The argument is that such a method of attack, in comparison with the use of ballistic missiles, reduces accuracy and sacrifices payload space in favor of an extensive command and control system—all for very uncertain gains.

Dept. of Defense analysts also state flatly that nuclear weapons in orbit are vulnerable—and that it is within the current U.S. operational anti-satellite capability to destroy them. Whether the President, given strong evidence that such weapons had been placed in orbit, would choose to thus destroy them, is another question.

The three-stage IBCM shown in the Red Square parade and alleged to be the orbital weapons carrier was first displayed in Moscow last May, and presumably was known to U.S. intelligence before then.



BIG BROTHER ICBM, above, has been labeled a potential carrier of orbital nuclear weapons by the Soviets. The three-stage, liquid-fueled vehicle has a thrust estimated in excess of 1 million lbs. Also holding a repeat performance in Moscow was the Iron Maiden tracked vehicle-carried missile (left), though the version displayed last week has a different case than that shown in May.

As one top military planner told MISSILES AND ROCKETS, "We have war-gamed these weapons every way possible, and it just doesn't come out as a logical thing to do. Of course, the Soviets have done things before which logic would not lead us to do. This then becomes a separate question.

"However, in the long run," he says, "you can predict Soviet behavior better by estimating what they should be doing rather than by getting too excited about what is paraded in front of us. With that in mind, I would be less surprised to see them come up with a truly mobile ICBM in the future rather than orbital nuclear weapons."

• **Early warning aspect**—There is, however, one possible loophole in the argument against orbital weapons, and that involves the potential for eliminating early warning time for U.S. forces. Exploiting this advantage would tend to cause problems primarily for Strategic U.S. Air Forces, the only major ingredient of the U.S. nuclear strike power which is dependent upon some warning to get all its forces airborne.

This has led some military planners to believe that the biggest military ripple the new Soviet claims are apt to make may be in the area of increased capability for the U.S. space track system.

This would primarily involve improving the ability to more quickly establish precise orbital parameters for "uncooperative" satellites, an activity which currently takes several orbits, and also to extend the ability to monitor de-orbiting vehicles to a global scale in order to recapture warning time no matter where an enemy chose to initiate re-entry. There would, of course, be no defense against these weapons once de-orbited unless an effective anti-ballistic missile system were developed.

The effectiveness of the other major elements of the U.S. nuclear strike force, the *Minuteman* ICBM and *Polaris* fleet, is not predicated upon early warning but on ability to ride out any nuclear attack.

• **Big targets**—For orbiting weapons to be militarily useful in this role, if all other problems can be solved, a large number of vehicles would have to be orbited. This certainly would unmask Soviet intentions and provide warning, in that a large number of large vehicles would not go undetected.

Defense experts estimate that the smallest Soviet nuclear weapon in orbit would involve relatively large vehicles, weighing at least 10,000 lbs. This would be roughly equivalent to the *Vostok* (10,400 lbs.), and *Voskhod* (11,700 lbs.) manned spacecraft and apparently within the capability of the three-stage *Big Brother* ICBM, which the Soviets also claim has been used for manned launchings. The *Big Brother* has been credited with a thrust in the neighborhood of 1.3 million lbs. and is probably liquid-fueled.

It is also estimated by informed sources that the weight of the very large, 50-megaton-class, Soviet weapons is in the neighborhood of 20,000 lbs., which, with control electronics added, would require an especially large orbital vehicle and launcher. However, the recent launchings by the Russians of two *Proton* satellites, each weighing just shy of 27,000 lbs, also signaled the operational availability of a new second-generation booster with a first-stage thrust estimated at between 2 and 3 million lbs.

The development of 50-megaton warheads is a good example of what the Russians have done in the past which U.S. defense planners say is militarily illogical. The orbiting of very large megatonnage in a single vehicle is discounted from all but the psychological standpoints. In fact, U.S. military experts say that because of the enormous size of these very large warheads, they would present a target almost impossible to disguise or decoy in an attack countered by any future ABM system.

The payload capability of the *Minuteman,* on the other hand, is said to be about 1,000 lbs., and a major effort is reported continuing to further reduce the size of re-entry bodies, thus improving penetration capabilities against any future defense.

- **Iron Maiden**—Among other items of interest in the Nov. 7 parade was the appearance of a modified version of the *Iron Maiden* track-mounted missile shown at the parade in May for the first time (M/R, May 17, p. 17) and judged to be 40-50 ft. long. The weapon moved through Red Square earlier this month was considerably longer, estimated to be at least 60 ft. On both occasions the missile was not visible, but encased in a heavy metal sheath. The newer case also had several changes, most notably a needle-like extension of the blunt forward end. The tracked vehicle carrying it was unchanged. Observers speculate that the solid-fueled *Iron Maiden's* range has been extended to possibly 1,500 mi.

U.S. planners, again relying on preliminary analysis, say they have still seen no hard evidence that Soviet missile mobility, obvious in the short- and intermediate-range weapons, has been extended into the intercontinental, 5,000-mi.-plus weapon category. Experts say the weapons "are moveable, but not mobile" in the sense of being self-contained units able to roam and fire from the countryside. There is no indication on ICBM's of the heavy hydraulics and blast-deflector type of appendages in evidence on missiles such as the *Iron Maiden.* ■

LASRV Gets Big Boost from Air Force

Ramjet engine by Marquardt is expected to be flown next summer on vehicle built by North American employing Aerojet booster

FIRST FLIGHT TEST of a new supersonic ramjet engine aboard a low-altitude hypersonic test vehicle will be made next summer at White Sands Missile Range, N.M.

The vehicles will be air-launched from F-100 aircraft. Results of these tests are certain to provide the Air Force with an important input regarding the design of future air-launched attack missiles able to fly at high speed and very low altitude to targets 100 mi. away.

The project will be carried forward under an $11-million Air Force Aeronautical Systems Div. contract to the Marquardt Corp., Van Nuys, Calif., for design, development, and fabrication of the ramjet engine. Though the contract was announced publicly only last week, Marquardt is believed to have been working on this program under AF funding for the past 3-4 months.

The test vehicle to carry the new ramjet will be developed by North American Aviation, Inc.'s Columbus (Ohio) Div. under subcontract to Marquardt. Aerojet-General Corp. will also be a subcontractor, providing a solid-propellant booster for the vehicle.

Supporters of the ramjet approach for low-altitude hypersonic missiles feel strongly that this technique will provide the answer to "on-the-deck" missile flight over the desired ranges. They question the ability of conventional chemical rockets to maintain performance at these levels over long ranges.

- **Potential for SRAM**—If the flight tests are successful, the current effort, which is limited to development of technology rather than a specific weapon system, could then be applied to advanced AF weapons beyond the currently proposed *SRAM (Short Range Attack Missile).* The intended range of *SRAM* is believed to be in the 50-100 mi. category.

There is some speculation, however, that if the tests next summer are successful, and the pace at which the *SRAM* is being pursued lags, the air-breathing system could challenge the rocket technology intended for use aboard *SRAM.* Marquardt's approach has reportedly attracted interest from the Martin Co. Martin and Boeing both hold definition-phase contracts on *SRAM* (M/R, Nov. 8, p. 10).

According to sources close to the project, seven test vehicles will be delivered under the new program, of which five will be complete flight-test models. Two are said to be primarily for stabilization and control checks. The AF program extends through the completion of flight tests, which should end late next year or early in 1967.

- **Early details**—The vehicle reportedly will include aft air inlets on the airframe rather than a nose inlet, which will allow guidance equipment and payload in the front end of the missile. There is said to be a minimum of aerodynamic surfaces on the vehicle. Maximum speed is said to be about Mach 3, according to informed sources. Use of a hydrocarbon fuel is likely.

The test vehicle, to be provided by NAA, is also believed to have considerable commonality with the existing *Redhead/Roadrunner* cruise-type target missile, although this will not be physically apparent. Most of the common usage is said to be in the electronics and radio command guidance. ■

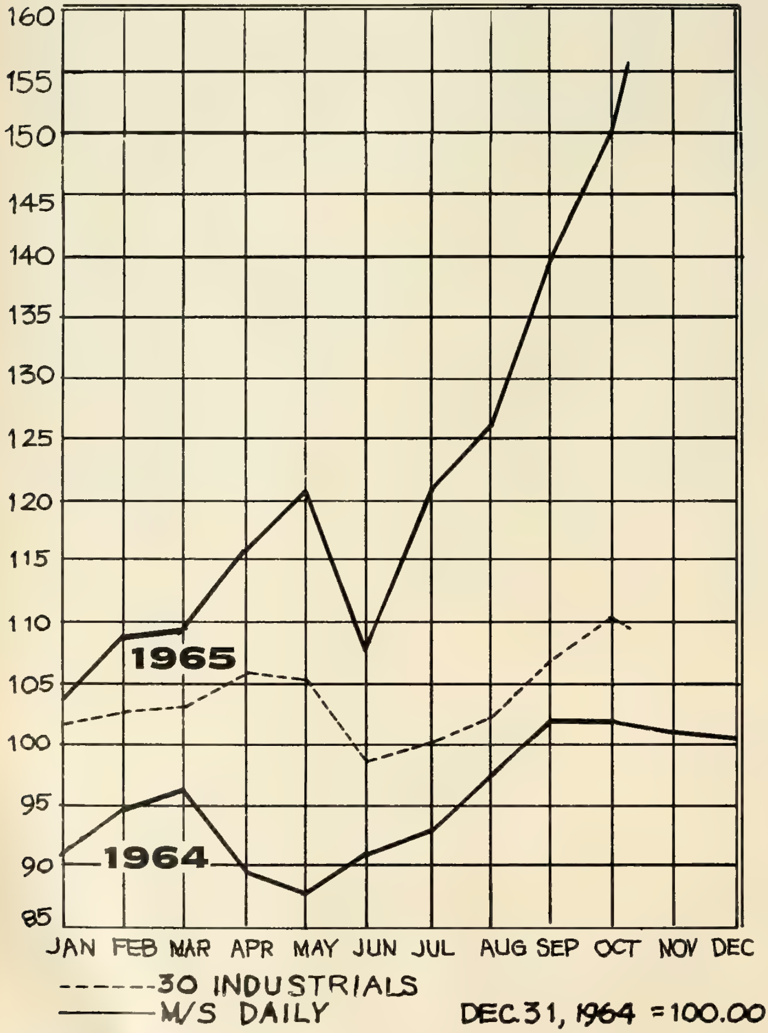
Aerospace Stocks in Strong Surge

Gains since first of year have been more than five times better than those of soaring industrials; analysts still bullish

by Heather M. David

GAINS MADE BY representative stocks of the aerospace/defense group since the first of the year have been more than five times as great as those made by a group of 30 stocks generally regarded as representing the industrial market.

Recent rises in the industrial group, although breaking records, have been far outstripped by the tremendous advances made by companies in the aerospace and defense field, which have had jumps ranging from 8 to 140% since the first of the year.



PERFORMANCE of 19 firms in the Missile/Space Weighted Stock Index compared with that of 30 stocks generally regarded as representing the industrial market.

In spite of the seemingly high prices at which the aerospace and defense stocks are now being traded, the group continues to offer good investment for the future, analysts say. Two recent analyses recommending individual companies within the aerospace group were issued by Standard & Poor's and The Value Line.

Stock in the major missile/space companies, stimulated by the Viet-Nam situation, a number of recent big R&D contract awards and large orders for aircraft from the airlines, has shot to new record after new record each week for the past several months. Very favorable financial reports and high earnings also have spurred interest in the issues.

- **Strange animal**—That the aerospace/defense stocks move as a group in response to events quite independent of those which affect the general stock market has been amply demonstrated by the behavior this year of the Missile/Space Weighted Stock Index.

At the present time, the Index has reflected a growth of more than 55% in the stocks surveyed, compared with only slightly better than 10% in the industrial group.

The Missile/Space Weighted Stock Index, which is calculated daily by MISSILES AND ROCKETS' Research Department, is comprised of 19 companies chosen to meet these criteria: sales of $200 million a year or better, half or more of which are in the defense/space market, and listing on the New York Stock Exchange.

The Index figure is reported daily in M/R's sister publication, *Missile/Space DAILY*, and weekly analyses are carried in both publications. The companies making up the Index are listed below, along with their stock prices at the first of the year 1965, their current prices, and the percentage change.

The biggest gainer in the group has been Ling Temco Vought, which has increased by 140.56% since the first of the year. Douglas has had a gain of 125.97%, Boeing 78.90% and Raytheon 78.46%. The companies with the smallest stock gain during the 10-month period have been North American Aviation, 8.47%, Avco, 9.28%, and Martin, 9.81%. The remainder have grown by one-third or better.

- **Gap widens**—A 10-month review of the behavior of the Missile/Space Weighted Stock Index and that of a group of 30 Industrial stocks dramatizes the contrast in their performance.

If the Industrial group were calculated in the same manner as is the M/S Index—that is on the basis that 100 represents the prices of the stocks on Dec. 31, 1964, the Industrial figure would now be about 110, while the Index figure is about 155.

At the end of January, the Index had already begun to pull away from the Industrial group, closing the month at 103.80 compared with the Industrial's equivalent of 102.31. The submission of the President's budget to Congress was particularly stimulating to the missile/space companies' stock, since the much-rumored declines in defense spending were not forthcoming. The stocks were all selling at favorable earnings-price ratios, and analysts began turning toward this group.

Tension in Viet-Nam began to build up during the next weeks, a factor which underlay the rise in these stocks throughout this entire 10-month period. In addition, however, the British government decided to depend upon some types of U.S. aircraft for its own defense, and commercial jet aircraft production was stepped up as airlines' demand increased.

By the middle of February, while the general stock market suffered a decline attributed to war jitters and worries over the instability of the British pound, aerospace/defense stocks were setting new records. The Index closed February at 109.49, the Industrial group at an equivalent of 102.83.

Talk of negotiation in Viet-Nam during the month of March and a rather slow period in terms of contracts caused a diversion of interest away from the missile/space stocks, which leveled off for a brief period. The Index closed at 109.71; the Industrial group still reflecting a more conservative upward trend closed at 103.07.

The Index started to take off in April as the Viet-Nam situation worsened.

Other factors such as huge jet orders—including one for $750 million from United Airlines, largely spent with Boeing—sent individual stocks up. Financial reports by large companies in the missile/space field reflected the tightening of management that grew out of the earlier defense decline scares. Higher profits, some on lower sales, were announced. The Index clearly outdistanced the Industrial group by the end of April, closing at 116.57 compared with an equivalent in the Industrial group of 106.04.

The situation in the Dominican Republic in May again emphasized defense, and the President made a request for an additional $700 million for a Southeast Asia Emergency Fund from the Congress. The space and defense budgets began emerging from a fairly generous Congress. The Index climbed to 120.33, while the Industrials fell back to 105.55.

At this point, William McChesney Martin Jr., chairman of the Board of Governors of the Federal Reserve System, said that the current economic situation looked a bit like that in the 1920's before the crash. This pronouncement itself caused a small crash, analysts said, and the Industrial group lost all its gains for the year. It fell below its year-opening figure, closing June at 98.23. The M/S Weighted Stock Index also lost ground, but recouped much more quickly and by the end of June was back up to 107. At no point did it fall as low as the rest of the stock market.

- **Higher still**—A number of large contracts were issued as the end of the fiscal year approached. Missile/space companies benefitted. It became increasingly evident that even more money would be needed to finance the Viet-Nam activity, as helicopter and aircraft orders increased. The Index closed July at 120.20, the Industrial average at 100.42.

The Secretary of Defense asked Congress for an additional $1.7 billion fund for Viet-Nam in August, and the Index climbed to 126.32, while the Industrial group managed a short climb to 102.68.

The space companies, particularly Douglas, got a boost with the long-delayed announcement of the *Manned Orbiting Laboratory* in September. Other large aircraft orders, continued escalation of the Viet-Nam situation, and a threat of war by India and Pakistan also provided stimulus.

The last week of September saw some wild gyrations in the stocks of contenders for the giant C-5A cargo aircraft contract, Boeing, Douglas and Lockheed. Speculators entered the market and the three stocks jumped from day to day in a manner which prompted an investigation by the Securities Exchange Commission. The probe is still under way, but the stock undoubtedly contributed a point or so to the Index, which closed at 139.83. The Industrial group closed the month at 106.99.

High third-quarter earnings were reported from most of the companies in the group. The flush of the C-5A contract award to Lockheed and its effects, which will filter down throughout the group, Commerce Department statements pointing to the increased backlog of orders in defense/space goods, and attention by financial surveys kept the Index going up. It closed October at 151.61, while the Industrial group was at 110.47.

November has already seen large gains, part of which are attributable to some extremely large contracts and aircraft orders in the first week. During the period, Douglas received almost $139 million in jet aircraft orders, General Dynamics got a $41-million *Redeye* missile contract, LTV a $95.6-million Navy A7A contract, and McDonnell signed a $198.6-million Phantom II pact. All broke previous stock records. In addition, the major helicopter face-off for the Advanced Aerial Fire Support System was won by Lockheed, which also jumped to new records.

The Missile/Space Weighted Stock Index has been adjusted to reflect stock splits in the group, three of which, at Grumman, United Aircraft, and TRW, Inc., have already occurred this year. ■

	Jan. 4	Nov. 9	% change
AVCO	21¼	23½	+ 9.3
BENDIX	44½	63	+ 42.4
BOEING	67½	123⅜	+ 78.9
DOUGLAS	29⅜	65⅞	+126.0
GENERAL DYNAMICS	36⅛	48¾	+ 39.4
GENERAL PRECISION	28⅜	37¼	+ 31.9
GRUMMAN *	26⅜	40⅝	+ 49.5
LEAR SIEGLER	12⅞	22⅝	+ 75.6
LTV	17⅜	42⅛	+140.6
LITTON	75	119⅛	+ 59.6
LOCKHEED	38⅞	64½	+ 68.4
McDONNELL	34⅝	51	+ 49.9
MARTIN	18⅛	19¾	+ 9.8
NORTH AMERICAN	53⅞	58⅝	+ 8.5
NORTHROP	21	28½	+ 36.5
RAYTHEON	21⅝	38¼	+ 78.5
THIOKOL	12	18¼	+ 52.0
TRW *	31 1/16	43¾	+ 40.0
UNITED AIRCRAFT **	42⅞	68¼	+ 57.0
M,S Stock Index	**100.00**	**155.45**	+ **55.5**

* Jan. figures adjusted for 2 for 1 stock split.
** Jan. figure adjusted for 3 for 2 stock split.

COMPANIES in Missile/Space Weighted Stock Index are listed, and their behavior charted since the first of the year.

New Third Stage Considered for Delta

UTC's FW-4 motor and Surveyor retro system studied for possible performance increase; no dissatisfaction with X-258

NASA IS CONSIDERING use of two rocket motors as a new third stage for the *Delta* launch vehicle.

Officials emphasize that the consideration stems from the possibility of higher performance rather than any lack of faith in the current third stage, Allegany Ballistic Laboratory's X-258 motor.

A NASA official said the two motors being studied as a possible new third stage are the United Technology Center's FW-4 and the *Surveyor* spacecraft retro-propulsion system.

If a decision is made to approve a new stage, it probably will not be done for at least a year, a NASA official told M/R.

The FW-4 motor has a thrust of 5,900 lbs. and a 29-sec. burning time.

It was test-flown successfully recently as the fourth stage on the *Scout* Evaluation test vehicle.

The *Surveyor* motor is being developed by Thiokol's Reaction Motors and has a thrust of 9,000 lbs. The X-258 has a thrust of 5,700 lbs.

The NASA official emphasized that NASA is satisfied with the X-258 motor despite some small anomalies in the *IMP-B* launch on Oct. 3, 1964, and its premature ignition during the *Orbiting Solar Observatory 3* launch on Aug. 25.

Noting *Delta's* excellent performance record, the official said the third stage has proved to be a reliable vehicle.

- **Report pending**—NASA's scientists are still checking into the anomalies.

"It appears that the tolerances on some motors are not as good as on others," William R. Schindler, *Delta* project manager at Goddard Space Flight Center, told M/R.

He said hydrostatic tests in which pressure in X-258 motors was built up to 500 psi indicate some deformities of parts and resultant more-than-anticipated deflection of the nozzle.

Nozzle deflection is a prime suspect in the solid stage's history of large-scale coning and tipoff, Schindler said, but he stressed that it is strictly a preliminary theory.

In repeated tests with apparently identical motors, parts on some were found to deform more than on others, indicating lack of qualitative uniformity.

"This leads us to believe it won't be necessary to change the design, rather to hand-pick good ones (motors) after the tests," Schindler said. He denied that the inconsistent quality of the ABL motor has Goddard shopping for another *Delta* third stage.

- **Good with GEOS**—The stage used in the Nov. 6 *Improved Delta/GEOS* satellite shot was "run-of-the-mill" hardware but performed well, burning the required 22.5 sec. and providing 5,760 lbs. of thrust.

Had the stage shown any anomalies, they would have been difficult to pinpoint because the special telemetry package included in some other flights was not aboard.

Schindler said the 35-lb. weight of the package precluded its use but the instrumentation probably would ride again on the next *TOS* (*Tiros Operational Satellite*).

So far, it has ridden three times—aboard *Deltas* that boosted *OSO-2* Feb. 3, *OT-1* (*Tiros X*) July 2, and *OSO-3* Aug. 25, 1965.

The latter failed to achieve orbit when the igniter squib in the third stage malfunctioned and caused premature separation.

Schindler said it appeared to have been a random failure. Of 500 initiators fired, it was the only one that showed weakness.

Nevertheless, the third-stage initiator has been slightly modified and 350 of the new units have since been test-fired without failure, including the component that correctly ignited the *Delta's* third stage in the *GEOS-A* launch.

The telemetry package produced meaningful data on *OT-1*, failed to prove anything on *OSO-2* and helped establish the cause of failure on *OSO-3* but was wiped out before it could perform its primary function, Schindler said. ■

Space Agency Tightens R&D Controls

NASA HAS ORDERED immediate implementation of a new four-phase management plan for large research and development programs.

The four steps are phase A—Advanced Studies; phase B—Project Definition; phase C—Design; and phase D—Development Operations.

The space agency defined a major research and development program as one that requires significant agency resources or involves important external relationships and will typically encompass design, development, fabrications, test and flight operation of major aeronautical and space hardware.

Among the examples listed were *Voyager, Advanced Orbiting Solar Observatory* (*AOSO*) and other spacecraft of observatory complexity, the hypersonic ramjet experiment, further utilization of *Apollo* systems, and post-*Saturn* launch vehicles.

- **For closer control**—In effect, the new policy gives top-level managers four separate opportunities to review major programs, thus affording them greater control over the use of agency resources.

Phase A effort involves the analysis of a proposed technical agency objective or mission in terms of alternate approaches or concepts, and the conduct of that research and technology development requisite to support that analysis and to assist in determining whether the proposed technical objective or mission is valid.

Phase B includes detailed study, analysis and preliminary design directed toward the selection of a single project approach from among the alternate approaches resulting from Phase A activities.

Phase C calls for detailed definition of the final project concept, including the system design and the bread-boarding of critical systems and subsystems, as necessary to provide reasonable assurance that the technical-milestone schedules and resource estimates for the next phase can be met, and that definitive contracts can be negotiated for Phase D.

Phase D effort includes final hardware design and development, fabrication, test, and project operations.

Technical Countdown

ELECTRONICS

In-flight Solar Cell Recovery Proposed

Westinghouse research scientists have developed an on-board baking system designed to restore radiation-damaged solar cells to near-original performance levels. Baking for a few minutes at about 850°F offsets the radiation-induced damage to solar cells. The Westinghouse concept envisions the use of a Fresnel lens to automatically scan the cell array, focusing the Sun's thermal energy on the cells at a command from Earth. The heating process must be done in vacuum and the space environment meets this requirement.

MATERIALS

Al Alloy 7039 Accepted by ASME

The American Society of Mechanical Engineers has granted Kaiser Aluminum and Chemical Corp. permission to use their aluminum alloy 7039 for the construction of welded, unfired pressure vessels in accordance with the ASME boiler and pressure vessel code. The alloy, designated —T61 in the heat-treated temper, has been accepted by the ASME boiler and pressure vessel code committee—as code case No. 1363—for utilization in sheet and plate thicknesses from 3/16 to 1¼ in. at temperatures as low as —320°F. Kaiser claims the alloy provides a 20% allowable stress advantage over 5083, the aluminum alloy now most widely used in cryogenic liquid storage tanks.

PROPULSION

LPC SRAM Contender Hot Fired

A three-pulse solid propellant, wafer-type motor has undergone a successful test firing at Lockheed Propulsion Co. after days of cycling between —75° and 200°F. The motor was fired at nearly 200°F in a horizontal bay for three varied periods, with shutdown times simulating a flight mission. The three pulses were fired on command from an instrumentation bunker. The demonstration was performed under contract with the Air Force's Rocket Propulsion Lab.

Booster Bending Control Avoidance Studied

Theoretical investigations covering control systems for minimizing the bending motions of large, flexible rocket boosters are in progress at Cornell Aeronautical Lab under a $61,000 contract from NASA's Marshall Space Flight Center. The primary objective of the program is to determine the feasibility of synthesizing a booster control system by linear optimal control analysis. Optimal control includes vehicle flexures caused by wind and other forces as dynamic motions to be controlled, along with basic vehicle motions. The project is expected to lead to a conceptual design of a flexible booster control system allowing less rigid, lighter booster structures.

Boosted Rooster Boosts Robin

To obtain weather data at twice the altitude reached by conventional *Arcas* sounding rockets (40 mi.), the Naval Missile Center at Point Mugu, Calif., has coupled the *Arcas* with a *Sidewinder* missile motor. The combination has been dubbed the "*Boosted Rooster*," following its adoption by the Air Force Cambridge Research Laboratory for an upper-air research program of that name. Payload is a "Robin Sphere." This is inflated at high altitude by evaporation of a volatile liquid, and is subsequently tracked by radar.

SPACE MEDICINE

Space Station Rotations Studied

General Dynamics/Convair has begun a new group of centrifuge tests in which 24 Navy flight instructors test subjects are being whirled for four hours each at 12.4 rpm. The experiment, supported by NASA's Manned Spacecraft Center, is aimed particularly at determining what tasks the men could perform in a rotating space station. Various head movements and other exercises are being performed. Equipment being used for the series, which will take 10 months to complete and analyze, is a manned revolving simulated space station placed on the arm of a giant centrifuge that revolves on an angle so that the floor of the simulator spins out to 45°.

AF Finds Heat Degrades Performance

Thermal tolerance tests conducted on humans at the Aerospace Medical Research Laboratories at Wright-Patterson AFB have yielded performance curves well below the recommended physiological tolerance curves set up in previous experiments. For instance, while the recommended physiological exposure limit for 89°F is four hours, significant deterioration was found to occur after only two hours of exposure. Eventually, performance decrements should be determined for a large number of combinations of temperature, humidity and air movement and reported in a tri-dimensional chart, Air Force scientists say.

Half of Suspected Heart Problems Aren't

An important service of the Air Force's School of Aerospace Medicine that may someday have ramifications for astronaut aspirants is a "Court of Last Resort" for airmen suspected to have heart problems. With the latest in scientific techniques to determine whether heart murmurs are benign or whether an occasional faint does or does not signify trouble, a group at the school headed by Dr. Lawrence E. Lamb has been able to return 1,273 fliers out of 2,608 referred to SAM to flying status—almost 50%.

FLUIDICS

Jet-Control Follow-on Awarded

The Aero-Propulsion Laboratory at Wright-Patterson AFB, Ohio, has continued its quest for application of fluidic controls to jet engines with a $2.7-million follow-on contract to Honeywell, Inc. Believed to be the largest single fluidics contract to date, the extension covers a three-year R&D effort. The advanced program calls for development of a more complex fluidic control system than that used to prove feasibility. It includes start-up, operation, and shutdown control functions. The integration of fluidic elements with non-fluid components will also be studied. In addition (but under the same contract), Honeywell's Aeronautical Div. will study "fluid control requirements for multiple engine applications to achieve optimum thrust stability control."

Avco Building Boron Filament Plant

Pilot facility in vapor-deposition method will have four production lines, two development lines; funded by Air Force

by John F. Judge

WILMINGTON, MASS.—A $600,000 vapor-deposition pilot plant for the production of boron filaments is being built at Avco's Research and Advanced Development Div. under Air Force funding.

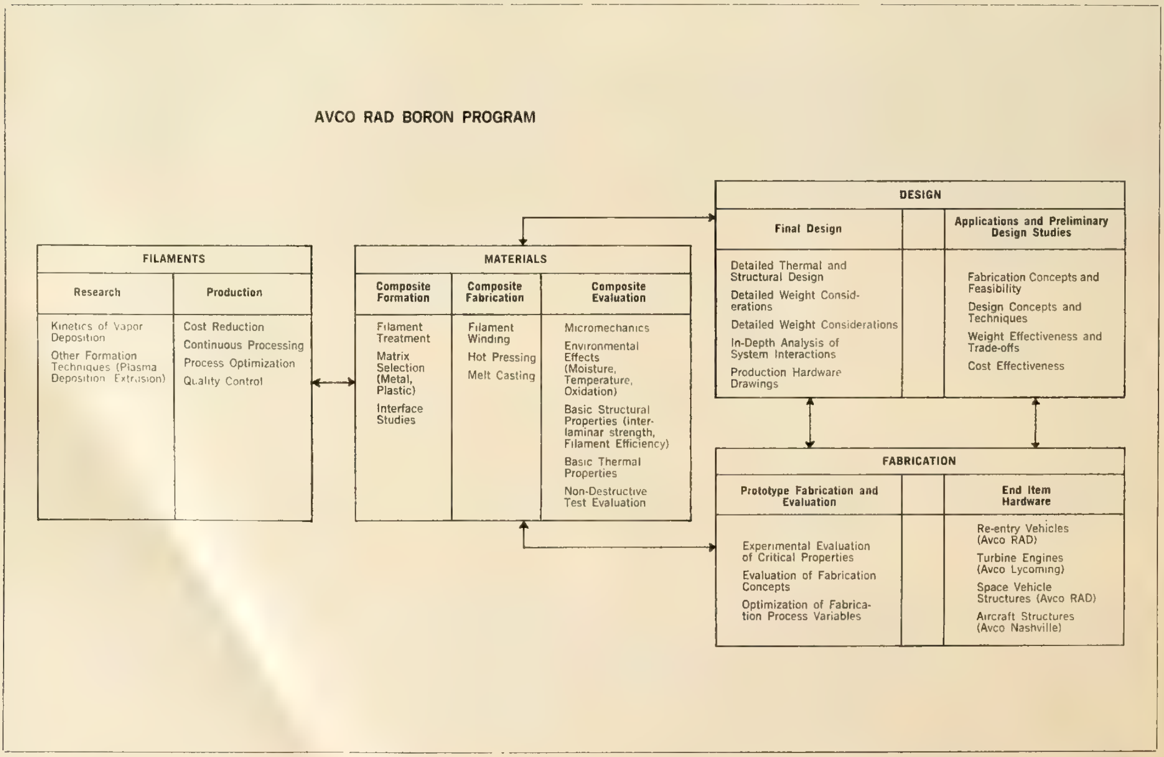
The pilot plant contract, together with other Air Force and in-house-supported programs in boron involves a completely integrated effort in boron technology from the manufacture of the filaments, through property characterizations alone and in reinforcing media into final applications for boron composites, at Avco/RAD.

The Avco boron filament process results from investigations into the chemical kinetics and mass-transfer characteristics of such systems. The chemical kinetics work provided Avco specialists with a detailed understanding of the vapor-deposition process.

The system provides a potential for a quantum jump in deposition rates and is no longer mass transfer-limited. Avco scientists studied the effects of temperature, materials concentrations, flow rates and additives on the boron-filament forming process and then developed detailed designs for production equipment.

● **Plant details**—The exact conditions and the equipment design are classified but the pilot plant will have four production lines and two development lines. The production units will be evo-

BORON technology at AVCO/RAD is considerably greater in scope than is indicated by present contracts with Air Force and several in-house projects. Knowledge derived from past and current boron work will be applied across the corporation as shown in the general flow chart below. The division has an in-depth ability in almost every phase of materials and composite technology—for instance—the non-destructive and destructive testing concepts required in boron work flow naturally from operations within the division wholly concerned with the technology of testing. This type of evolvement aids in reaching the design and fabrication stages that are the ultimate aim of any basic materials work at Avco/RAD. The Materials Technology Directorate also markets elemental boron in ultra-fine powder form in semi-production quantities.


AVCO RAD BORON PROGRAM
FILAMENTS
Research
Production
Kinetics of Vapor Deposition
Other Formation Techniques (Plasma Deposition Extrusion)
Cost Reduction
Continuous Processing
Process Optimization
Quality Control
MATERIALS
Composite Formation
Composite Fabrication
Composite Evaluation
Filament Treatment
Matrix Selection (Metal, Plastic)
Interface Studies
Filament Winding
Hot Pressing
Melt Casting
Micromechanics
Environmental Effects (Moisture, Temperature, Oxidation)
Basic Structural Properties (interlaminar strength, Filament Efficiency)
Basic Thermal Properties
Non-Destructive Test Evaluation
DESIGN
Final Design
Applications and Preliminary Design Studies
Detailed Thermal and Structural Design
Detailed Weight Considerations
Detailed Weight Considerations
In-Depth Analysis of System Interactions
Production Hardware Drawings
Fabrication Concepts and Feasibility
Design Concepts and Techniques
Weight Effectiveness and Trade-offs
Cost Effectiveness
FABRICATION
Prototype Fabrication and Evaluation
End Item Hardware
Experimental Evaluation of Critical Properties
Evaluation of Fabrication Concepts
Optimization of Fabrication Process Variables
Re-entry Vehicles (Avco RAD)
Turbine Engines (Avco Lycoming)
Space Vehicle Structures (Avco RAD)
Aircraft Structures (Avco Nashville)

lutionary in the sense that a constant effort will be made to optimize cost and production rates consistent with acceptable boron filaments. The key to the process success is precise control of the operating conditions.

The two development lines will be used to create techniques to improve the overall process through the testing of automation approaches, additives and other research approaches.

Improvements thoroughly checked on the development lines will be fed into the four production lines. The main restraint is that the end product must always be filaments meeting general application specifications.

The 13-month pilot plant contract originated with Advanced Filaments and Composites Div. of the Air Force Research and Technology Division's Materials Lab at Wright-Patterson AFB. The plant is being designed for possible scale-up and the buildings involved at Avco allow for significant enlargement of the production lines.

Design freeze of the four production lines is slated for mid-December. Equipment assembly and shakedown operations are scheduled for completion by March, 1966. Full operation is expected at that time.

Boron filament output will go to the Air Force Materials Lab for testing and applications to composite development activities and into hardware component development. The four lines will produce 20 lbs. of boron filaments per month.

Avco has been working with boron as a reinforcement for more than two years. One of the division's main materials interests is in composites—for re-entry, advanced structures and other sophisticated applications.

The pilot plant is one of four current Air Force contracts in boron technology at Avco/RAD. One contract to be completed by March, 1966, covers boron from filament production through basic applications to plastic composites including evaluation of both destructive and nondestructive testing procedures.

Two other boron-oriented contracts are in the initial phases—one covers research into metal matrix composites and the other involves studies of the micromechanics of filament-reinforced metal composites.

- **Boron blanketed**—In addition to the vapor-deposition kinetics research, Avco has probed other filament production concepts. These include powder extrusion, electric arc means of handling the boron reaction and subsequent deposition on a substrate, gaseous and melt-vapor deposition and electrical deposition from a fused salt bath.

Direct drawing from the melt has been investigated but Avco experts decided the development time needed to overcome the characteristics of boron in this production process was too long for any reasonable, short-time transition to economical manufacturing status.

The boron work is concentrated in the research and technology section of the division under Dr. Paul R. Hoffman, director of materials technology, and Dr. R. S. Timmins, manager of the material sciences department. Bert Coplan handles the boron pilot plant operation.

Hoffman says the alternate concepts in boron filament processing are not being pursued at the moment at Avco. After coordinating with the Air Force, Avco decided to concentrate on optimizing the vapor deposition method—where boron is deposited at temperature on a thin substrate such as tungsten in a continuous process. The angle of attack came through the chemical kinetic work.

Composite efforts in boron have been generally directed to the problem of interlaminar shear. Avco results are now at the 15,000-psi level. Other areas include improving the surface condition of the filaments to get good wetting and bonding characteristics.

A filament etching process has been developed and could be incorporated into the pilot plant. Etching smoothes the jagged peaks left on the surface of a deposited boron filament. The end product is still not totally smooth—the etching reduces the surface irregularities and improves both the interlaminar shear in a composite and cuts the filament moisture susceptibility. Moisture-resistant coatings are in development.

- **Filament/metal area**—The Air Force-funded metal matrix program is a systematic laboratory research effort aimed at establishing the understanding necessary to adequately assess the full potential of boron-reinforced metal composites.

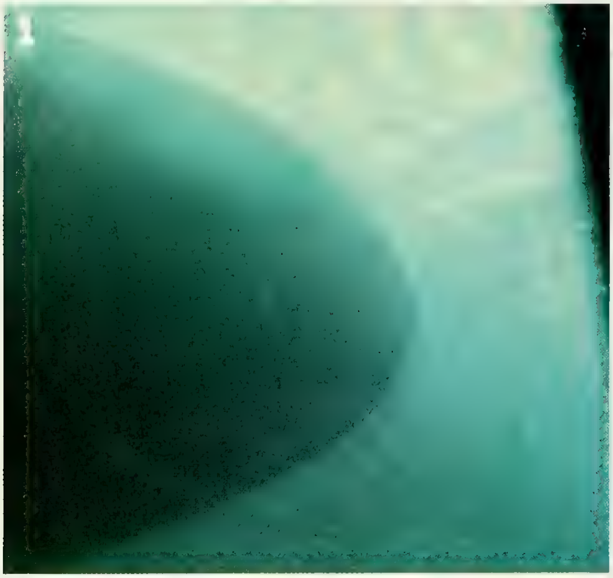
The major portion of the investigation will involve aluminum alloy matrices with some work in copper, tin, bismuth and lead. A transparent matrix material will be used for photoelastic analyses.

Two general fabrication processes will be used—powder metallurgical methods and melting-casting techniques. The chemical interaction of the highly reactive boron filament and the matrix is considered by Avco researchers to be a major problem.

The powder metallurgy fabrication process will involve hot pressing in vacuum. Much of the boron work at Avco is in oriented filament composites. There are both in-house and contracted efforts in the area of randomly oriented boron-reinforced composites. Avco researchers have experience in random reinforcement involving many fiber

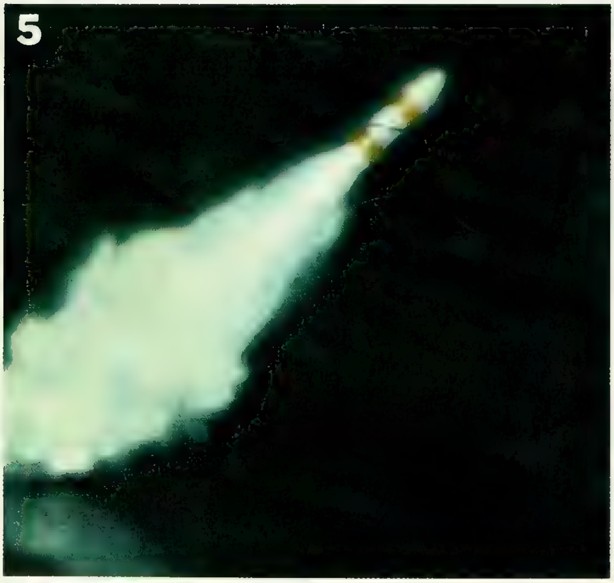
BORON deposition process developed at Avco/RAD is essentially similar to the conventional process. Filament material is shown being drawn through the deposition furnace. A mixture of boron compounds in vapor form, plus a gas—probably hydrogen—is passed through the coating chamber. The mixture reacts with the heated tungsten wire substrate and deposits boron in a non-crystalline form. Details of the Avco process are not known, but the increased deposition rate potential is the result of investigations into the chemical kinetics and mass-transfer characteristics of such systems.

SUBROC combines the surprise of a t



Bow of a nuclear attack submarine.

SUBROC fired from torpedo tube.



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SUBROC...success story i

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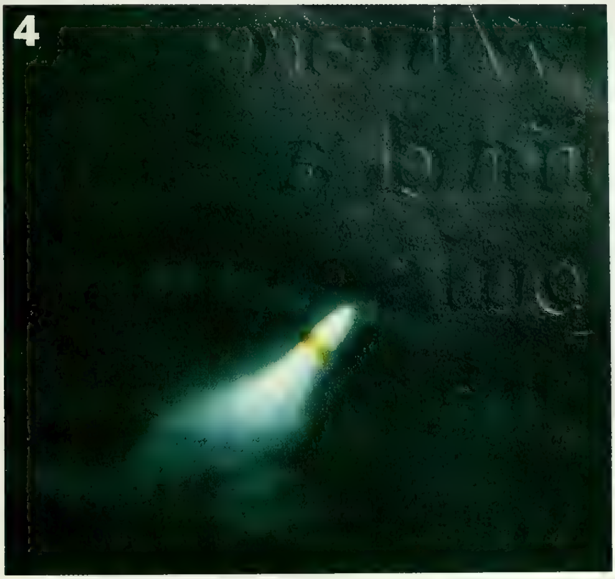
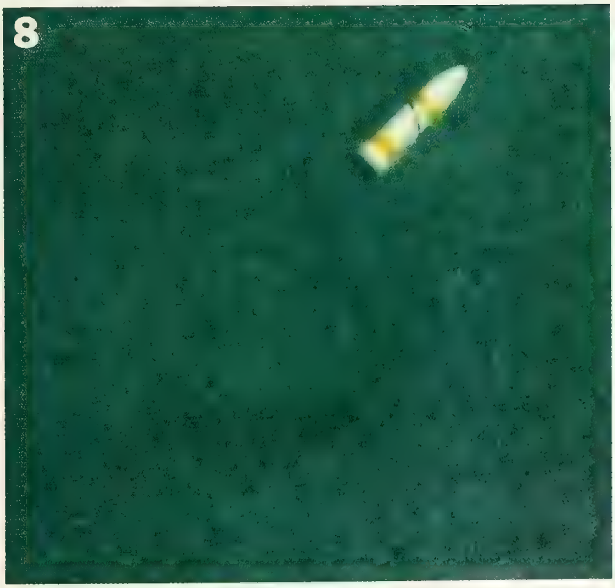


SUBROC emerging from water to airborne flight.

d separation of warhead from booster.



Nuclear warhead on course to enemy submarine.

eapon system management

ery system was to be a nuclear attack submarine and veapon to be launched from the torpedo tube. Detection, king, fire control and the configuration of the missile f . . . were tailored to these tight parameters. The pron's success is a triumph over obstacles on which an ult had never before been made.

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GOODYEAR
AEROSPACE

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Lockheed's achievements in the new technology of solid pulse motors stand unrivalled—more than 130 individual pulse firings performed for the Air Force. LPC was first to combine the simplicity of a solid motor with the restart capability previously only available in liquid engine systems. And today, it is still the most experienced pioneer in this new propulsion breakthrough.

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LOCKHEED PROPULSION COMPANY
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materials. The division's experts are abreast of the state of the art in this technology.

A variation on the hot pressing approach has been suggested by Avco. This involves coating the boron filaments by drawing through a melt or using electroplating techniques. The coated filaments would then be processed by hot pressing into the desired final shape.

- **Melting-casting**—The melting-casting technique consists of supporting coated boron filaments in a mold and pouring the molten matrix material over them. The coatings are designed to prevent or inhibit boron interaction with the matrix metal.

Composites made by both methods will then be evaluated with respect to compatibility in aqueous solutions acidic, neutral and basic in nature. The specimens will be tested in dry oxygen at high temperatures, and the composite behavior in all environments will be compared with the behavior of the metal matrix alone and the boron filaments alone. Mechanisms of corrosion—both direct and through electrochemical attack—will be determined.

Procedures will be developed and tested to improve the composite compatibility with the environment under investigation.

Both the mechanical and physical properties of metal/boron composites will be studied in a comprehensive program designed to fully characterize the materials.

The micromechanical behavior study will use boron filaments in a castable aluminum matrix. The composite was chosen by Avco for this research effort because of the large amount of data now available, ease of fabrication, inherent low density and probable early utilization in advanced structural composites.

The minimum aim of the investigation is to achieve:

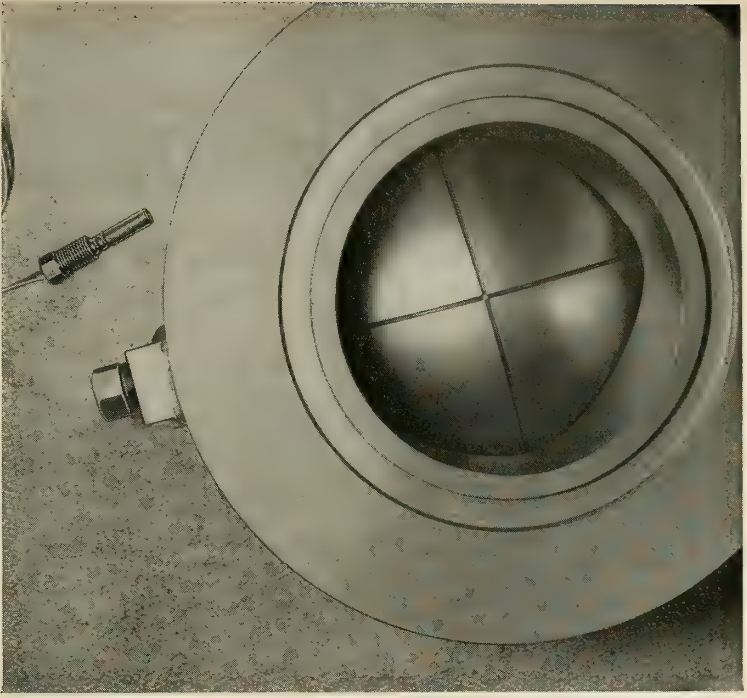
—Quantitative understanding of the distribution and magnitude of residual stresses;

—Temperature yield criterion for the components of the composite;

—Associated flow rules governing plastic deformation.

Hoffman and Timmins are aware that the emphasis on boron should lead to a better understanding of high modulus composites in general, and other advanced reinforcements are under active research—especially silicon carbide filaments and fibers.

The major problems with boron are first, the establishment of an economical and efficient filament manufacturing process and second, the development of the data and confidence levels needed to design structures. ■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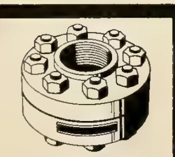
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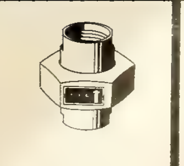
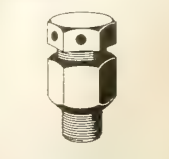

UNION-TYPE RUPTURE UNITS


SCREW-TYPE RUPTURE UNITS

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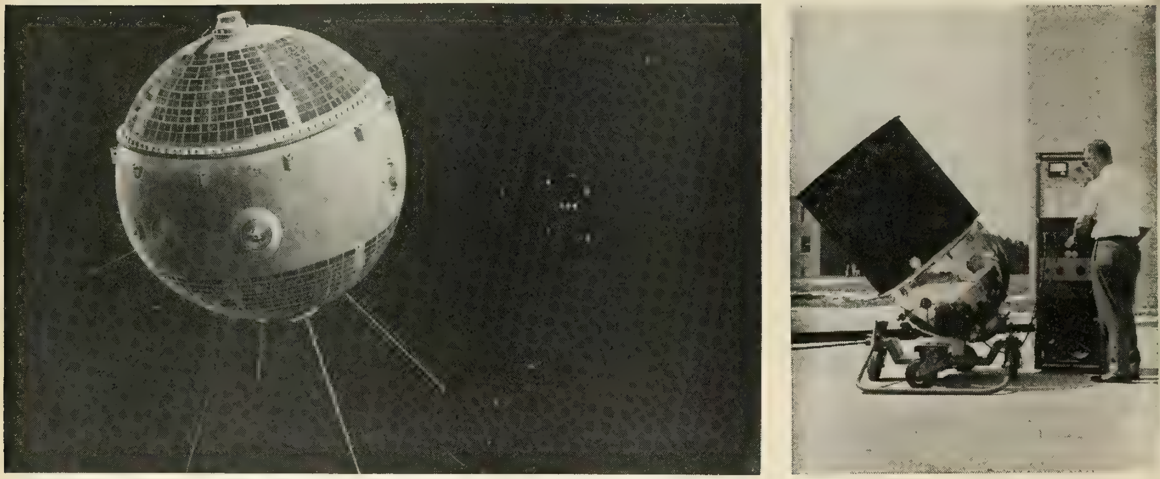
AE-B To Probe Higher in Atmosphere

Goddard aeronomy satellite, second in series, demonstrates maturing of technology; aim is to develop data on unknown regions

by William S. Beller



LEFT: Artist's conception of Atmosphere Explorer B (AE-B) satellite in orbit. RIGHT: Shroud tops satellite and is open to the Sun in a test of the efficiency of the solar-cell matrix. Except for band around equator, shell is covered with cells.

THE RADIATIONS, particles and their energies making up the Earth's upper atmosphere will be analyzed for distributions, concentrations and anomalies by the second in a series of NASA-Goddard Space Flight Center aeronomy satellites, scheduled for launch next spring.

The first aeronomy satellite, *Explorer XVII*, known as *Atmosphere Explorer A (AE-A)*, was launched April 2, 1963. Data from it, which Goddard scientists will publish soon, "clearly indicate the need to extend the measurements to higher latitudes and over other geographic locations," according to a justification for the follow-on *Atmosphere Explorer B (AE-B)* satellite.

An unusual aspect of the Goddard aeronomy satellite program is the standard, almost casual way in which succeeding spacecraft are designed, developed and launched. Nobody is criticizing this attitude, which reflects a confidence on the part of the experimenters that members of other projects might envy. It merely points up the maturing of a technology, one in which the emphasis has switched from forging the tools to their actual utilization.

This point was brought out by Larry Brace, *AE-B* project scientist, who, when asked the significance of the *Explorer B* satellite and experiments, told M/R, "This package is a good example of a continuing technology getting down to detailed and refined measurements."

In the same vein, Chris C. Stephanides, Project Manager, said "*AE-B* will be used for the further study of the composition and physics of the upper atmosphere." He said the next step after *AE-B* will be *AE-C*, probably launched in 1969 or 1970 during heightened sunspot activity.

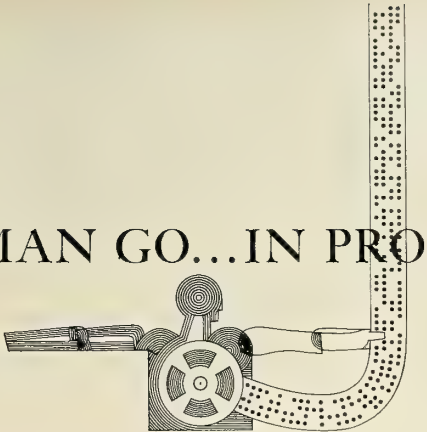
• **Comparisons** — The best-known contribution of *AE-A* was to confirm that the Earth is surrounded by a belt of neutral helium at an altitude of 150-600 mi. Overall objectives were to measure the density, composition, pressure and temperature of the Earth's atmosphere within the satellite's orbital range and to find out how these quantities varied.

AE-B is designed to extend both the the altitude and geographic range of the earlier satellite. Thus, while *AE-A* achieved an orbital inclination of 57.6° to the equator, the orbital plane of *AE-B* is to be inclined 64°. At the same time, *AE-B*'s perigee will be increased to 750 mi., but its apogee will be the same as *AE-A*'s, if current plans are carried out.

The need for the extended coverage of *AE-B* was clearly indicated by its predecessor and other scientific satellites. For instance, comparison of *AE-A* data with data from the topside sounder program shows a possible difference in energy propagation between the region over Singapore and those over similar latitudes in the Western Hemisphere. These measurements "suggest significant anomalies yet to be uncovered at other, as-yet-unexplored regions of the 'magnetic' atmosphere, which will be accessible to the *AE-B* satellite," states a current NASA document.

To this end, *AE-B* is acquiring a tape recorder, will use active magnetic attitude-control and spin-rate-control systems, will have significantly increased lifetime through the help of solar power, and will be able to relieve through a

WHERE CAN MAN GO…IN PROGRAMMING?



From abacus to computer, human progress can be measured in increments of man's skill in processing data. Originally no more complex than the fingers of one hand, computer systems are today truly revolutionizing the very times in which we live. For as civilization grows ever more aware of the skills of these uncanny servants, so too grow in importance the programmers who initiate and then interpret all that these instruments are able to accomplish. Program: A trajectory for optimum ballistic flight far out in space. Program: Simulation studies. Program: Advanced software. Real-time management, and business systems. In brief, wherever there exists the need to do things better: Program. Lockheed offers an unusually wide range of advanced programming tasks at one of the world's largest centralized industrial computer installations. Write Mr. K. R. Kiddoo, Professional Placement Manager, Sunnyvale, California. Lockheed is an equal opportunity employer.

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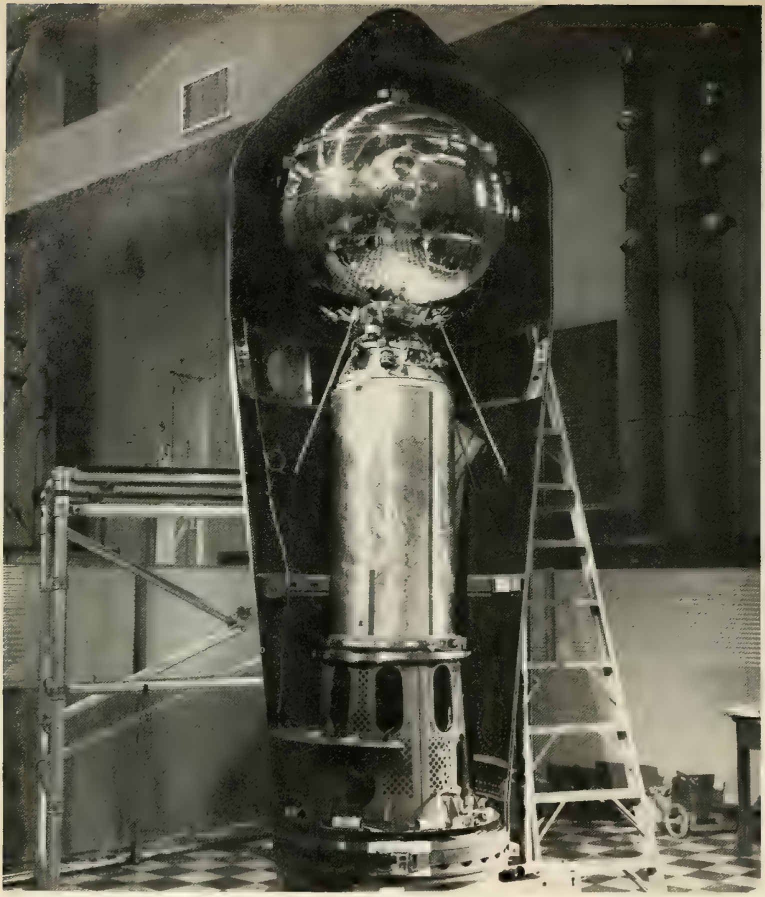


AE-B IS SET in third stage of Delta launch vehicle to check out its fit.

unique method the pressure built up in the satellite by the outgassing of the batteries.

Moreover, the *AE-B* will have a spectrometer on board, which the *AE-A* did not have. The *AE-A* was able to measure the spectra of neutral particles only, but the presence of the new instrument will make it possible to measure the spectra of charged particles as well. In addition, cold-cathode or magnetron-type density gages will be flown instead of the filament type used before.

To make sure data are transmitted, *AE-B*, unlike *AE-A*, will have a redundant programming and telemetry system.

• **Spacecraft**—Weighing 485 lbs. the *AE-B* will be made up of a 35-in.-dia. stainless-steel spherical shell with appropriate internal structures and instruments. It will be launched by a *Delta* vehicle from the Atlantic Missile Range. Except for a broad band around *AE-B*'s equator, the satellite shell will be coated with solar cells. Appendages include a canted turnstile antenna, and electron temperature and density probes.

Stephanides says that the satellite is expected to behave in orbit much like the *Tiros* cartwheel satellite, with sensors able to sweep along the velocity vector. To do this, the satellite spin axis will be maintained normal to the orbital plane. Ambient-gas-sampling sensors will thus be able to sample particles in the direction of satellite motion as well as in the opposite direction.

To get this type of control, *AE-B*, unlike the *A*-version, will use a spin-axis orientation device—to be provided by the Applied Physics Laboratory—that upon command will enable control of the satellite's residual magnetic field, and therefore the orientation of the spin axis. *Explorer XVII*, in which no such control was used, experienced a precession of about 10° a day, and thus only infrequently achieved desired orientation.

• **Power**—Although both aeronomy satellites were designed to use multiple silver-zinc power packs with a total capacity of 10,500 watt-hours, only the second spacecraft has a recharging capability. This together with other technological improvements and reduced power demands is expected to give *AE-B* a lifetime of six months; *AE-A* had a design lifetime of 90 days, lasted 100. With the addition to *AE-B* of the solar-cell modules, which are expected to feed in five watts on the average for the six-month design lifetime, the satellite may be effectively active an entire year. "At least, this is the hope," says Stephanides.

• **Pressure relief**—A fuel cell in reverse will be used in *AE-B* to help cure the pressure build-up problem experienced by *AE-A*. When last interrogated *AE-A* showed an increase of four times its launch atmospheric value of internal pressure. Since *AE-A* was sealed, as *AE-B* will be, the increasing pressure came from contained hydrogen and oxygen generated by the batteries. A shorted fuel cell will be included in *AE-B* to recombine the gases into water. This method is expected to keep the internal pressure at launch pressure for about nine months, at which time a motor-driven vacuum valve will permit a slow leak rate of the gases, about a pound a day, on command.

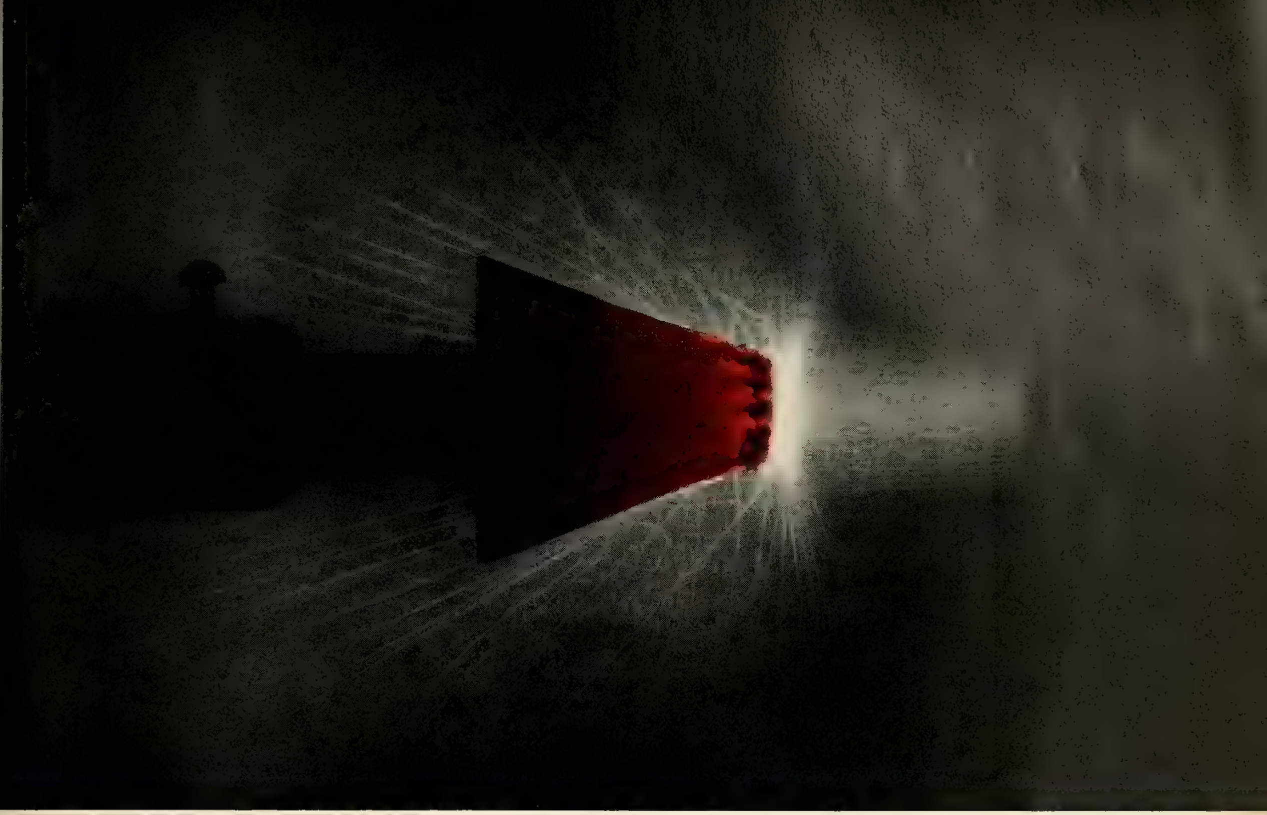
• **Control**—The attitude control of the spin axis will be achieved by generating a magnetic dipole moment within the satellite which will react with Earth's magnetic field to produce spin-axis precession. At 30 rpm, the precession rate will be nominally ¼°/minute.

The spin-rate control will similarly be achieved by means of a magnetic dipole moment generated in the satellite and properly oriented and phased with respect to the Earth's magnetic field. This moment will produce a torque to increase or decrease the spin rate. The sense of this torque may be selected by command. This system will be able to change the spin rate 15 rpm per 24 hours of system operation. When the spin rate system is "on," the power demand will be less than one watt.

A three-axis fluxgate vector magnetometer system will measure the magnetic field components at the sensors and provide output signals proportional to these fields. These outputs will be telemetered to the ground for use in determining satellite altitude in space. The output signals will also be used to control the spin-despin electronics.

• **Instruments** — The sensors in *AE-B* will be rearranged, with respect to *AE-A*, in locations that take advantage of the controlled orientation. Thus, nearly equally spaced on the satellite's equator will be a neutral-particle mass spectrometer, an ion-mass spectrometer, two magnetron-density gages, two electrostatic probes, and one optical aspect system.

One neutral-particle mass spectrometer will be on the spin-axis "top," and one magnetron-density gage will be 55° off the equator, near the "top." ■



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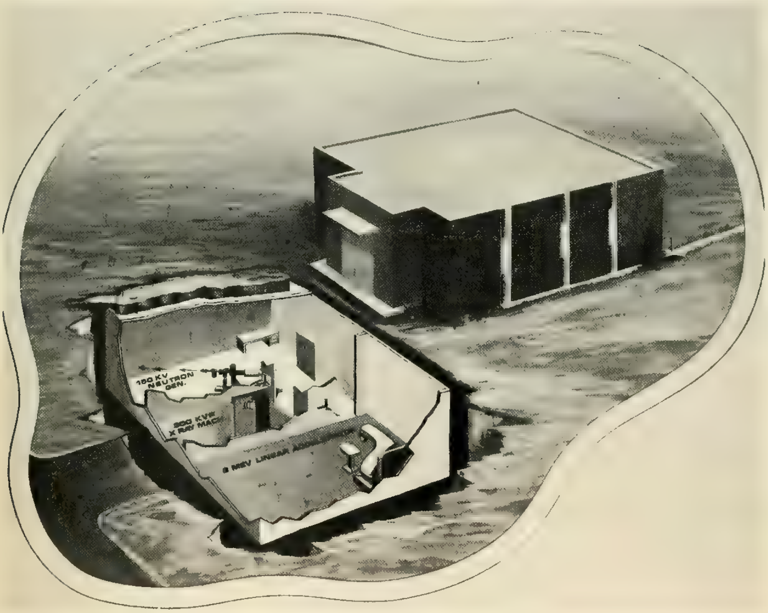
New Lab Will Speed Radiation Studies

Plant to be completed early in 1966 at Air Force's School of Aerospace Medicine will offer wide range of exposure equipment

by Heather M. David



ARCHITECT'S CONCEPTION of bionucleonics lab being completed at SAM.

San Antonio, Tex.—The Air Force's attack on the problems of radiation in space will be stepped up greatly with the completion of a new bionucleonics laboratory here at the Air Force Systems Command's School of Aerospace Medicine.

The new installation, scheduled for completion early next year, will have separate exposure facilities for several types of radiations. Equipment will include a 150-kilovolt neutron generator that will furnish beams of neutrons with a wide spectrum of discrete energies, a 300-kv X-ray machine, and a 6-Mev linear electron accelerator to furnish the repeated bursts of electrons that may be encountered in space.

These will be used to study effects on cells, protein molecules and other biological specimens using an electron spin resonance spectrometer and by neutron activation analysis techniques. In addition, effects on radiation dosimeters will be looked at.

The facility is part of an overall, three-pronged approach to the space radiation problem by the Air Force, which includes:

—Development of dosimeters for flight in satellites and routine rocket test flights to complete data on the actual radiation picture in space;

—Exposure of animals to various kinds and combinations of radiation to assess the exact biological effect produced by each kind;

—Application of this information to determining astronaut dose levels and programs.

• **Space probes**—The Air Force Weapons Laboratory at Kirtland AFB, N.M., is charged with the design and development of dosimeters to measure the physical radiation environment. The dosimeter package, which weighs 20-25 pounds, has been flown 10 times to date and six to eight more flights are now in progress or are being planned.

The package contains both active and passive devices to measure linear energy transfer (LET), dose rate, total dose, and tissue equivalent chambers for extrapolation to human experience. No biological dosimeters are planned by the Air Force, since they would require recovery for analysis.

Another device that has not yet been flown, but has been in the works for some time, is the "plastinaut", a full-sized anthropomorphic dummy of an astronaut. It is constructed of a plastic that will absorb radiation in the same manner as does human tissue.

All data on radiation in space are being fed into a computer program developed by the Boeing Co. for SAM.

Some of the data gaps of particular interest to the Air Force at this time include the South American anomaly and solar flare conditions.

• **Biological studies**—The Air Force is now winding up a major program that has been in progress for more than a year in which monkeys have been exposed to various energies of proton radiation to assess the relative biological effect of one type of space radiation as compared with others, such as X-ray against gamma radiation.

Using a modified KC-97 transport plane, groups of 100 to 150 monkeys at a time have been transported to various cyclotron facilities throughout the country, wherever time could be arranged for biological experiments.

Each group was taken a day or so in advance to get baseline data and to accustom the animals to the environment. After the exposure, they remained at the site for 24 to 48 hours while early samples of blood and tissue and other medical measurements were made.

According to Lt. Col. Milford Harris, chief of Radiobiology in the Aerospace Medical Division's R&D office, the range of energies studied included 14 Mev—which is the amount deposited in the subcutaneous tissue; 32

Mev—which appears to penetrate through the muscle to about the depth of the ribs; 55 Mev—which produces bone marrow effects; 138 Mev—which appears to distribute equally throughout the entire body; 22 Mev, 440 Mev, 800 Mev, and 2 Bev. The 2-Bev exposure is to be done at Brookhaven National Laboratory.

In general terms, in the exposures thus far, it appears that, except for the very low energy group, the symptoms from proton radiation occurred a little earlier and were a little more severe than with comparable exposures of other types of radiation. However, the relative biological effect (RBE) of all types for practical purposes, Air Force scientists said, was "one."

In similar work, a group of SAM researchers led by Capt. Glenn V. Dalrymple compared the irradiation of mice with 138-Mev protons and cobalt-60 gamma radiation delivered at 86, 256, and 550 rads per minute. They reported that doses of 865 rads and more of protons produced relatively more gastrointestinal injury than did the same doses of cobalt-60 gamma radiation. However, total mortality through 30 days was the same for both.

All exposed animals are studied for various biological effects until mortality.

The Air Force is very interested in proceeding in the near future with simulation on a cyclotron of a solar flare with the entire spectrum of energies and types of radiation that might be involved. At the present time, there is no facility capable of producing this range, although some thought is being given to the problem.

With the new electron facility at SAM, a range of electron exposures will be studied next year. Starfish-type numbers will be of particular interest.

- **Setting astronaut doses**—A new concept gaining currency among Air Force scientists is that rather than limit astronauts to one permissible lifetime dose of radiation, a sliding exposure schedule should be set up which takes into account the astronaut's age, recovery periods in between exposures and other variables.

According to Col. John Pickering of the School of Aerospace Medicine, crews could be integrated on one-, three- and five-year plans each as separate programs but closely related so that holdovers, less adept crews, or those which have exceeded a pre-determined dose schedule can be moved to longer time schedules.

Recovery rates would be allowed at the rate of one week of rest per one rad of dose sustained, Pickering suggests.

Younger astronauts, from 22 to 25, would be assigned to the longest utilization schedule, the concept says. The oldest, 35 to 37 years, could be allowed to use up their permissible dose in the shortest time schedule, such as one year.

Such a schedule would allow decision-makers an opportunity to operate on a less-than-chance basis, Pickering says, since each flight and the cost in terms of radiation exposure can generally be determined beforehand.

By taking into account the specific talents of each astronaut, whether he is a scientist with a specialized skill, a physician or a test pilot, the mission schedule can be programmed and experiments planned.

Scientific evidence and experimental results were taken into account in drawing up the concept. ■

DOSE PLANNING CHART
RAD

		Sub Total	Flare	Total
1 YEAR MAN	25	25	100	125
2 YEAR MAN	25 20	45	100	145
3 YEAR MAN	25 20 15	60	100	160
4 YEAR MAN	25 20 15 10	70	100	170
5 YEAR MAN	25 20 15 10 10	80	100	180

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Aerojet Pleased with Commercial Entry

Aerometrics Div. aims at applying specialized capabilities to marketing of general industrial equipment; will reach 50% in non-aerospace sales in first year

by Rex Pay

BEVERLY HILLS, CALIF.—A first-quarter profit has encouraged Aerojet-General Corp. in its efforts at turning esoteric know-how to commercial profit through a new industrial operation.

Aerojet, after studying the attempts of 28 other aerospace firms, set up the Aerometrics Div. last March in Sacramento to market industrial instruments, ultrasonic equipment, a brazing furnace and special laboratory apparatus.

Deliveries of the brazing furnace have reached $500,000 and an order backlog of $1.25 million has been accumulated. This is expected to rise to $10 million soon. The division's staff has been increased from 23 to 90 and is expected to reach 200 by Dec. 1. Instrument sales are targeted at $20 million by the end of the first five years.

The experience of the 28 other spin-off organizations showed the importance of independence. "It seemed to us that one of the most important criteria was isolation from aerospace activities and from a busy aerospace manager, whose time is very much dominated by the customer," said R. H. "Mike" Dow, manager, Aerometrics Division, in an interview with MISSILES AND ROCKETS.

Initially Aerometrics was planned as a subsidiary, to give it the necessary isolation. But, in fact, it was made a division. "This has the advantage that you don't have to go to the bank," said Dow. "It has given us freedom to bid on large jobs that a small firm starting up could not have considered."

• **Running counter to advice**—Consultant teams from both Stanford Research Institute and Arthur D. Little were called in to check through the development plan for the proposed division. Both thought the product line was too large.

"I disagreed with this," said Dow. "Product cycles are so short that it is difficult to start a business with only one or two products. Our philosophy is to continue with a relatively large number of products, and we aim to continue innovating. We plan to maintain a high percentage of products in the high profit portion of the product cycle.

"I was so convinced that a large number of products was important, that I was able to override all the good advice we had," said Dow. "Someday I'll know whether I was right or not."

"We've tried to build a pretty big fence between us and the space centers," he added. "Aerometrics is self-supporting in the areas of marketing, sales, purchasing, manufacturing and quality control. If we fail it will be because we were not good enough."

• **Sales outside the family**—Aerometrics had expected that 70% of the first-year sales would be to aerospace concerns and had targeted for 50% non-aerospace sales in the third year. But the 50% level will be reached by the first year, which both surprises and pleases the division.

Aerometrics was advised to leave Sacramento to avoid labor problems. But Dow thought it was good judgment to stay. "Our locals are very interested in the growth of commercial enterprises to replace some of the lost jobs in aerospace, and have been extremely helpful in establishing the necessary conditions to contribute to our success," he said.

Nucleus of the staff at Aerometrics came from the test instrumentation division at Sacramento. Dow was previously manager of that group, which contained about 280 engineers and scientists. "These designers and a good nucleus of patents formed a basis for the instruments portion of our business."

The line moving really fast is the infrared brazing furnace, developed in Aerojet's Solid Rocket Research Div.

Another product line was developed partly by acquisition. Aerometrics bought the inventory and assets of Electro-Sonic Systems, largely because of a patent ESS held for an ultrasonic flow meter. Aerometrics had an electronic phase meter accurate to 20 seconds of arc that would make this flow meter a very accurate device.

The fourth product line is highly specialized apparatus, including a differential thermal analyzer that operates at temperatures up to 3,600°C and a melting-point furnace with millidegree precision at 4,000°C. Aerometrics decided to get into this business largely because of customer demand. The instruments had been developed for aerospace research and Aerojet had a backlog of requests to duplicate them.

As the four lines develop, they will be broken out as cost centers, said Dow, and can be augmented, merged, or sold.

• **How to market?**—Marketing is the big problem, acknowledged Dow. It faces any big aerospace company that wants to diversify. "You have to develop a marketing organization from scratch and this is a problem that you have to get your management to recognize. We are really only beginning," he admitted.

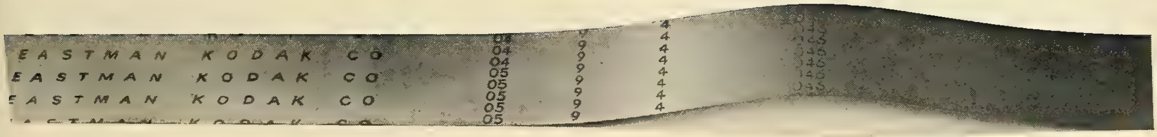
A network of manufacturing reps is being built up for the instrument line. In the ultrasonic equipment line, Aerometrics is manufacturing for firms that have sales organizations and applications. The laboratory apparatus side of the business is of necessity a factory sales type of operation. Currently, an international stocking and distribution system is being set up for the furnaces.

First instrument to be marketed by Aerometrics is a 10-mc. digital counter. In a field where a great deal of competition already exists, the division aims to make full use of silicon integrated circuits to cut size, weight and price, and to boost performance. "We market a counter that weighs 7 lbs., costs $1,450, and has specs comparable with a counter that weighs 40 lbs. and costs $3,600," claimed Dow.

In addition to instruments, Aerometrics has pressure, temperature and flow transducers developed for aerospace control applications. The division's thrust in marketing will be to try to take some of this new technology into industrial control. Building blocks such as these will ultimately give a systems capability in process control.

A feature of the Aerometrics transducer is that it has a 0-30 ma output and will drive a servo directly. Small sales have been made so far, but process control is a hard market to break into with electronic equipment. A few large sales could set an important trend. ■

Traceability now assures positive data identification



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This breakthrough has eliminated one of the major problems in data tape recording. For no longer can important projects be hindered or delayed due to a mixup in reels. The possibility of misplaced data is now virtually a thing of the past.

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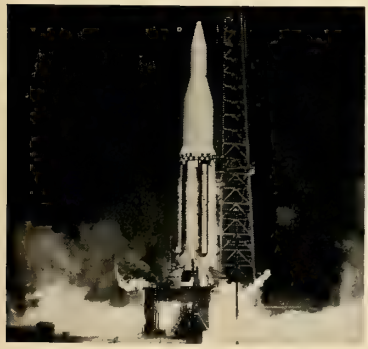

For example, on every 15 inches of tape there appears an internal Kodak reference number which immediately identifies the tape by type; and every 30 inches there is a numbered tape signature which provides an index to the coating and test records for that particular production block. So efficient is this coding method, it is possible—through the numbers on the tape, reel, can, or box—to trace any roll of tape all the way back to the master web from which it came.

However, digital coding is only one of the significant reasons why CEC Magnetic Tape is rapidly changing the state-of-the-art.

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▣ Only CEC tapes are so precisely differentiated that users are no longer subjected to the time-consuming burden of performance evaluation.

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▣ Only CEC tapes are protected from shipping and storage damage by means of a plastic waffle hub, thus preventing tape serration and flange deformation.

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Mergers and Acquisitions

McDonnell Aircraft Corp. is transferring the business of its electronic equipment division in St. Louis and its Tridea Electronics Co. subsidiary in Pasadena, Calif., to Conductron Corp., Ann Arbor, Mich., in exchange for an undisclosed amount of Conductron stock. Although the terms of the deal were withheld, McDonnell is said to have obtained a controlling interest in the transaction. McDonnell has owned some 21% of Conductron stock for the past year. . . . *McIntyre and Gage, a San Francisco investment firm, has acquired an interest in Engineering Test Services of Tulsa, Okla. ETS is engaged in the field of ultrasonic testing, providing services and instruments.* . . . Allied Products Corp., Chicago, has purchased the assets of Epoxy Products, Inc., of Irvington, N.J., for an undisclosed amount of cash. Epoxy Products will become part of Allied's new Chemical and Plastic Products Div. Epoxy Products makes patented encapsulation systems for electronic devices, epoxy formulations, molding powders and molded parts. . . . *Transitron Electronic Corp., Wakefield, Mass., has acquired Electra Manufacturing Co., Independence, Kan. Both firms are engaged in the production of integrated circuits.* . . . McNeil Corp. directors have turned down the terms of a proposed merger with TRW, Inc., (M/R, Nov. 1, p. 39), but merger negotiations between the two firms are likely to continue, according to McNeil Chairman Charles F. Safreed.

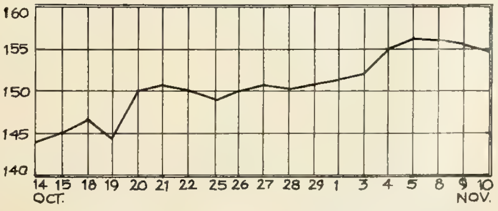
New Activities

American Aluminum Co., Mountainside, N.J., has established a hydroforming department to perform job and production work for the space, aviation, electronics and automotive industries. . . . *Pressure Chemical Co., Keokuk, Iowa, has formed a new Fiber Div. to produce metallic, nonmetallic, alloy and coated fibers.* . . . Moog, Inc. East Aurora, N.Y., producer of aerospace control systems and industrial products, has been listed on the American Stock Exchange. Ticker symbol for the firm will be "MOG." . . . *Tektronix, Inc., Beaverton, Ore., has registered 635,000 shares of its common stock with the Security Exchange Commission as a secondary offering. An underwriting team led by Lehman Brothers is to begin marketing the securities in early December.*

Facility Expansions

Air Products and Chemicals, Inc., Allentown, Pa., will begin construction this month of a 21,000-sq.-ft. building to house the company's advanced cryogenic development activities. A large portion of the new facility will be devoted to designing and developing new types of cryogenic refrigeration systems. . . . *Sperry Rand Corp.'s Univac Div. will build a 47,000-sq.-ft. addition to its Blue Bell, Pa., plant and has taken an option on 200 acres near St. Paul, Minn., with the announced intention of building a 280,000-sq.-ft. engineering and manufacturing facility during 1967. Univac recently moved its headquarters and staff from the Sperry corporate offices in New York to Blue Bell.* . . . Haveg Industries' Super Temp Wire Div. has announced the beginning of construction of a new plant in Ethan Allen Industrial Park, Colchester, Vt. The structure will expand Super Temp floor space to a total of more than 75,000 sq. ft. . . . *Cornell University and the University of Illinois have both begun construction of space research centers. NASA contributed $1.35 million toward the total cost of the $1.5 million Cornell facility; $1.125 toward the $2.8 million center at Illinois.* . . . Ohio University has received a $200,000 satellite tracking station from Standard Oil of Ohio. In exchange, Ohio University is to provide SOHIO with information and reports of the station's activities to aid the company's efforts to remain in contact with space program activities. . . . *Maxson Electronics has bought the U.S. Naval Ordnance Plant in Macon, Ga., for $6.76 million. The price covers the entire facility, including a 343-acre site, 121 buildings, manufacturing machinery and equipment, plus a contract for the continued production and delivery of some $16 million of current ordnance work.* . . . Varian Associates, Palo Alto, Calif., has authorized architectural and engineering studies for the construction of a 150,000-sq.-ft. building to house the firm's Vacuum Div. and all its facilities. The Vacuum Div. makes high vacuum equipment, including pumps, systems, instrumentation and components. . . . *Delburn Electronics, Inc., has moved to new 6,000-sq.-ft. quarters in Yonkers, N.Y. The company is a distributor of military and industrial capacitors, semiconductors, resistors, transformers, wire and cable, and chokes and coils.* . . . Sperry Rand Corp. is building a 105,000-sq.-ft. extension to its Sperry Phoenix Co. facilities in Phoenix, Ariz. When the building is completed in May, 1966, employment is expected to be increased from 1,800 to approximately 3,000. Products made in Phoenix include automatic flight controls, compass systems and flight instruments for aircraft. . . . *Goodyear Aerospace Corp. is building a plant in Jackson, Ohio, to facilitate the firm's expansion into the commercial reinforced plastics field. Goodyear Aerospace has been a long-time supplier of reinforced plastics for the defense industry.*

Missile/Space Stock Index



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contracts

AIR FORCE

$6,439,907—**ITT Corp.**, Nutley, N.J., for electronic counter-countermeasures.

$5,710,425—**Sperry Rand Corp.**, New York City, supplemental contract to continue production of *Shrike* radar-homing missiles.

$2,000,000—**Thiokol Chemical Corp.**, Bristol, Pa., for work on air-breathing solid propellant rockets.

$1,238,275—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., to continue work on the *Gemini* program.

$79,875—**Aerojet-General Corp.**, Liquid Rocket Operations, Sacramento, Calif., from Ogden Air Material Area for *Titan II* engineering support services.

ARMY

$3,000,000—**Honeywell, Inc.**, Minneapolis, Minn., to produce classified electronic equipment.

$2,852,720—**Chamberlain Corp.**, Waterloo, Iowa, initial segment of a $5,353,920 contract for 2.75-in. rocket components.

$2,072,564—**Baifield Industries**, Los Angeles, for production of classified Army weapon dispensers.

$1,884,443—**General Dynamics Corp.**, New York City, to continue research and development of *Redeye* air defense missiles.

$1,333,309—**Albion Malleable Iron Co.**, Albion, Mich., an initial segment of a $2,502,324 contract for 2.75-in. rocket components.

$1,213,500—**Ling-Temco-Vought, Inc.**, Dallas, to manufacture classified electronic equipment.

$1,119,740—**Astrodata, Inc.**, Anaheim, Calif., for continued range testing.

$1,051,900—**Philco Corp.**, Philadelphia, modification to an existing contract for electronic equipment.

$847,854—**Douglas Aircraft Co.**, Santa Monica, Calif., for studies on hardpoint defense systems (as part of ARPA's Project Defender).

$266,886—**General Electric**, Syracuse, N.Y., for FY 1966 *Hercules* mobile HIPAR technical publications.

$117,184—**Washington Engineering Services Co.**, Kensington, Md., for FY 1966 *Lance* documentation review services.

$99,939—**General Electric Co.**, Santa Barbara, Calif., from the *Nike-X* Project Office for an additional R&D study, entitled Radar Degradation.

$55,731—**Philco Corp.**, Western Development Labs, Palo Alto, Calif., for additional work in connection with design, development, fabrication and installation of a satellite communications control facility, auxiliary items and tech reports.

$44,900—**Purdue Research Foundation**, Lafayette, Ind., for investigation of high acceleration on the interior ballistics of solid propellant rocket motors.

NAVY

$37,927,262—**Bendix Corp.**, Detroit, to make guidance control, air frame and related test equipment for the *Talos* air-defense missile.

$2,222,000—**Raytheon Co.**, Lexington, Mass., to produce *Polaris* guidance components.

$1,360,525—**Sperry Rand Corp.**, New York City, to make classified electronic equipment.

$354,250—**Westinghouse Electric Corp.**, Chicago, from the Naval Electronics Supply Office for magnetron tube assemble.

$60,000—**Howard Research**, Arlington, Va., for R&D on *Poseidon* missile.

NASA

$450,000—**Bell Aerosystems Co.**, Buffalo, N.Y., from Headquarters for a study of Teflon bladder design criteria for use in the expulsion propellant tanks of *Apollo* and *Lunar Orbiter*.

$377,500—**Westinghouse Electric Corp.**, Baltimore, from Goddard Space Flight Center for *Applications Technological Satellite* Mojave ground station integration and test.

$300,000—**Northrop Corp.**, Ventura Div., Newbury Park, Calif., for development and test of a new controllable gliding parachute designed for glided landing manned space vehicles.

$287,677—**General Electric Co.**, Pittsfield, Mass., from Marshall Space Flight Center to perform component tests, system checkout, evaluation, performance analysis and summary report for MK II gyro and its cryostat.

$193,218—**Avco Corp.**, Electronics Div., Cincinnati, Ohio, from Marshall Space Flight Center for 20 more secure range safety decoders and an updated instruction manual.

$167,987—**American Bosch Arma Corp.**, Garden City, N.Y., from Headquarters for study of the feasibility of conducting gravity gradient experiments in earth and lunar orbits on manned missions.

$134,375—**Fairchild Hiller Corp.**, Rockville, Md., from Goddard Space Flight Center for radio astronomy experiment tooling.

$120,400—**Barringer Research, Inc.**, East Natick, Mass., from Headquarters for spectrometric measurement of tracer components of planetary atmosphere.

$95,093—**General Electric Co.**, Cincinnati, Ohio, fom Goddard Space Flight Center for simulated radio isotope thrust system and component development.

$94,370—**Hughes Aircraft Co.**, Space Systems Div., Los Angeles, from Manned Space Center for study to determine optimum lunar lighting conditions for LEM touchdown point.

$84,744—**Allied Research Associates**, Aracon Geophysics Co. Div., Concord, Mass., from Headquarters for meteorological experiments for manned earth-orbiting missions.

$83,860—**Beckman Instruments, Inc.**, Advanced Technology Operations Div., Fullerton, Calif., from Manned Spacecraft Center for cardiovascular reflex conditioning systems for *Apollo* Experiment MI-A.

$75,095—**Lockheed Missiles & Space Co.**, Sunnyvale, Calif., from Headquarters for conceptual design and optimization of measurement devices for biomedical and human factors testing for orbital research laboratory concepts.

$70,171—**Douglas Aircraft**, Missile and Space Systems Div., Santa Monica, Calif., for a study of thermal absorption in seeded hydrogen.

$67,000—**North American Aviation**, Los Angeles, from Flight Research Center to design and fabricate a respiration analyzer.

$58,856—**Webb Associates, Inc.**, Yellow Springs, Ohio, from Headquarters for study on metobolic time constants.

$49,800—**TRW, Inc.**, Systems Group, Redondo Beach, Calif., from Ames Research Center for study to determine an efficient data format and data system for lightweight deep space probe.

$46,000—**Wyle Laboratories**, Testing Div., Huntsville, Ala., from Manned Space Center for study and development of a pneumo-acoustic transducer.

$39,735—**North American Aviation**, Los Angeles, from Ames Research Center for computer program for propulsion system dynamic simulation.

$37,000—**Operations Research Inc.**, Silver Spring, Md., from Goddard Space Flight Center to develop monitoring system performance specifications in conjunction with a new telemetry installation.

$31,992—**Cosmodyne Corp.**, Torrance, Calif., from Kennedy Space Center for valve-type cryogenic samplers.

INDUSTRY

$22,000,000—**Avco Corp.**, Research and Advanced Development Division, Wilmington, Del., from **North American Aviation, Inc.**, Space & Information Systems Div., Los Angeles, follow-on to fabricate ablative heat shielding material for additional *Apollo* spacecraft.

$3,500,000—**Wyle Labs, Inc.**, El Segundo, Calif., from **North American Aviation, Inc.**, Space & Information Systems Div., El Segundo, Calif., for high-level vibration and acoustic testing of portions of the S-II second stage of the *Saturn V* rocket.

$1,005,000—**Radio Corp. of America**, Aerospace Systems Div., Burlington, Mass., two contracts from **Grumman Aircraft Engineering Corp.**, Bethpage, N.Y., for ground support equipment in connection with the LEM program.

$500,000—**Canoga Electronics Corp.**, Chatsworth, Calif., from **Kentron Hawaii, Ltd.**, Honolulu, for the construction and delivery of four telemetry tracking installations.

$450,000—**United Aircraft Corp.**, Norden Div., Norwalk, Conn., from **North American Aviation, Inc.**, El Segundo, Calif., for production of linear amplifier microcircuits to be incorporated into *Minuteman* missile systems.

$341,662—**Space Ordnance Systems, Inc.**, El Segundo, Calif., from **Grumman Aircraft Engineering Corp.**, Bethpage, N.Y., for a man-rated pyrotechnic-actuated separation system to be used aboard the Lunar Excursion Module.

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Cb

Density at 68°F (lb/in³)	0.31
Melting Point (F)	4480
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Linear Expansion (per °F)	4.06x10⁻⁶
Thermal Conductivity (BTU/Ft²/in/sec/°F)	0.1
Specific Heat (BTU/lb/°F)	0.065
Electrical Resistivity (microhms-cm)	12.5

Ta

Density at 68°F (lb/in³)	0.6
Melting Point (F)	5430
Modulus of Elasticity (psi)	27x10⁶
Linear Expansion (per °F)	3.6x10⁻⁶
Thermal Conductivity (BTU/Ft²/in/sec/°F)	0.1
Specific Heat (BTU/lb/°F)	0.034
Electrical Resistivity (microhms-cm)	12.45

Mo

Density at 68°F (lb/in³)	0.369
Melting Point (F)	4750
Modulus of Elasticity (psi)	42x10⁶
Linear Expansion (per °F)	2.7x10⁻⁶
Thermal Conductivity (BTU/Ft²/in/sec/°F)	0.27
Specific Heat (BTU/lb/°F)	0.066
Electrical Resistivity (microhms-cm)	5.8

W

Density at 68°F (lb/in³)	0.697
Melting Point (F)	6100
Modulus of Elasticity (psi)	52x10⁶
Linear Expansion (per °F)	2.55x10⁻⁶
Thermal Conductivity (BTU/Ft²/in/sec/°F)	0.32
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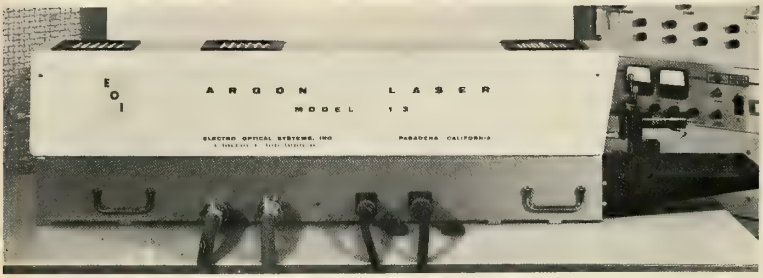

New Product of the Week: Argon Laser

An ionized argon gas laser of the type used in *Gemini* spacecraft experiments is being marketed by Electro-Optical Instruments Div. of Electro-Optical Systems, Inc.

The Model 13 is said to be the first continuous wave argon system to use a failure-free discharge tube. The 3-mm-dia. discharge chamber is fabricated from ceramic and guaranteed failure-free for 300 operating hours. It has shown no deterioration after continuous testing for 1,000 hrs. at a beam current of 15 amps, the firm says.

The unit offers seven output wavelengths between 4,545 and 5,145 Angstroms in addition to two primary frequencies at 4,880 and 5,145. Nominal power output is 1 watt with a beam divergence of less than 3 milliradians. Input power is 240v, single phase, 100 amps, 60 cps with input threshold of 2.5 kw.

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Scanning Systems

Uresco, Inc., is marketing a series of automatic scanning systems for ultrasonic immersion inspection of all metal and many plastic materials.

The GP300 series are general-purpose units featuring all-pneumatic controls and operating circuits. Scanning speed can be varied from full stop to 30 ips; index increment can be adjusted throughout the full range of 0 to 0.5 in.

A feature of the unit permits adjustment of scan width using a single panel-mounted control. Scan width varies about "midpoint," which may be repositioned to any location across the tank. Centering of the recorder readout is automatic.

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Transmitting Material

An infrared transmitting material, effective from 2 to 30 microns and free of absorption bands over the spectral bandwidth, has been developed by Eastman Kodak Co.

The Irtran 6 material is made of hot-pressed cadmium telluride and is designed for applications involving low-temperature sources where extended wavelength response is required. It has a refractive index of 2.67 at 10 microns; modulus of rupture is about 5,500 psi and modulus of elasticity 6.4 x 10^6 psi at room temperature. The material has a polycrystalline structure and grinds and polishes relatively easily when using conventional techniques, the firm says.

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Miniature Vibrometer

A miniature vibrometer, developed for extreme-temperature and nuclear applications, is being marketed by Physical Sciences Corp.

The Model VT-1001 is said to be the first instrumentation for vibratory displacement measurement in cryogenic or thermal temperatures and under heavy radiation. The device is unaffected from −323° to 1,200°F and has a near-inert radiation response. It is available for vibration up to 0.25-in. double amplitude at frequencies from 50 to 1,000 cps. Frequency response is flat ±5%, 50 to 1,000 cps. Thermal sensitivity shift is ±0.01% of full scale per degree F. Combined error due to linearity and hysteresis is ±5% of full scale. Insulation resistance is 50 megohms minimum at 50v dc between coils and case.

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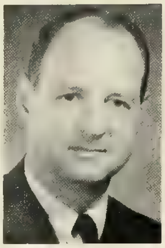

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William C. Bennett: Joined Precision Instrument Co. as vice president-marketing. He will direct the world-wide marketing of the company's magnetic, digital and analog recorders.

Dr. Kurt Burian: Appointed vice president in charge of engineering at Littelfuse, Inc. He holds five patents on electro-magnetic devices.

J. W. Shaver: Appointed director-international marketing of the Douglas Missile & Space Systems Div. He will direct the planning, development and promotion of programs to market the division's products and services abroad.

Harold Hechtman: Appointed press relations manager of Cutler-Hammer. He will continue as director of public relations for the Airborne Instruments Lab Div. and will be responsible for the corporate press relations of the Milwaukee-based electrical and electronics company.

Horace A. Shepard: Elected a director of the Standard Oil Co. He succeeds T. Keith Glennan. Mr. Shepard is president of TRW, Inc.

Robert C. Harris: Appointed military contracts supervisor for U.S. Gauge, a division of Ametek, Inc.

Ralph Shapcott: Named vice president of Warner Electric Brake & Clutch Co.'s Beaver Precision Products, Inc. He was president of the Industrial Controls Divison of General Precision, Inc.

Joseph E. Smith: Appointed vice president and general manager of Ex-Cell-O Computer Products Corp. He has been involved in and largely responsible for the development of the computer memory systems produced by the corporation and its subsidiaries.

Al Barsimanto: Named vice president of Concertone, division of Astro-Science Corp. He will be responsible for Concertone's product and marketing development and expansion program.

John M. Holm: Joined the Astronautics Div. of LTV Aerospace Corp. and named manager of the company's Houston office. For the past 2½ years, he was marketing manager for the Emerson Electric Co's. Southern Region.

Dr. Glover S. Colladay: Joined the staff of the Center for Naval Analyses of the Franklin Institute as director of the surface effects ships project. He was formerly assistant technical director and head of the weapons planning group at the U.S. Naval Ordnance Test Station.

George K. Bramet: Appointed president of Technical Products Co. He succeeds **E. R. Chilcott,** who becomes chairman of the board. **Robert C. Moody** has been appointed vice-president, engineering.

Gordon S. Brown: Elected a director of instruments and automatic industrial controls at Leeds & Northrup Co.

William M. Veazey: Named vice president of the Eckoustic Division, the Eckel Corp. He will be in charge of new product development as well as for improvements in the design and fabrication of the Eckoustic line of products.

Frank B. Gorman: Appointed director of planning for CBS Laboratories. He recently retired from the U.S. Navy where he was director for Plans and Advanced Technology at the Secretary of the Air Force Special Projects Office.

William E. Birks: Appointed senior representative and manager of Motorola Company's office in Houston. He will represent Motorola's capabilities in electronics research, development and production to NASA, military departments, other U.S. Government agencies and principal aerospace contractors.

Philip C. Efromson: Joined the engineering staff at Ling Electronics, a division of LTV Ling Altec, Inc., Anaheim, Calif. He will be senior engineer of special vibration projects.

Jack Peterson: Named director of technology for Scientific Data Systems. He will be responsible for the design, development, and control of such basic SDS elements as electronic modules, semiconductors, mechanical packaging, and power supplies.

Dr. George W. Rathjens, Jr.: Appointed director of the Weapons Systems Evaluation Group of the Institute for Defense Analyses. He is back with IDA after serving with the Advanced Research Projects Agency and the Arms Control and Disarmament Agency.

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Lecture on "Nonlinear Optics" sponsored by the Advanced Research Projects Agency, the Pentagon, Washington, D.C., Nov. 15.

Fall National Meeting of the Society of Aerospace Material & Process Engineers, sponsored by the Society of Aerospace Material and Process Engineers, Biltmore Hotel, Dayton, Ohio, Nov. 15-17.

1965 Atomic Fair and Winter Meeting of the American Nuclear Society, sponsored by the American Nuclear Society, Sheraton Park Hotel, Washington, D.C., Nov. 15-18.

International Congress on Air Technology, sponsored by the Valley Education and Research Foundation and the Arkansas Industrial Development Commission, Hot Springs National Park, Ark., Nov. 15-18.

Fourth Annual Symposium on the Physics of Failure in Electronics, co-sponsored by Rome Air Development Center, Griffiss Air Force Base, and IIT Research Institute, Grover M. Hermann Hall, Illinois Institute of Technology, Chicago, Ill., Nov. 16-18.

National Conference for Space Age Facilities, sponsored by the Florida chapters of the Society of Civil Engineers, Aerospace Transport Div., Society of American Military Engineers, Canaveral Council of Technical Societies, and the Florida Engineering Society, Ramada Inn, Cocoa Beach, Fla., Nov. 17-19.

International Conference on Tropical Oceanography, sponsored by the Institute of Marine Science, Institute of Marine Science, Miami, Nov. 17-24.

International Symposium on Electromagnetic Sensing of the Earth from Satellites, sponsored by the University of Miami, American Meteorological Society, American Geophysical Union, Optic Society of America, University of Miami, Coral Gables, Fla., Nov. 22-24.

1965 Fall Computer Conference, Convention Center, Las Vegas, Nev., Nov. 30-Dec. 2.

1965 Ultrasonics Symposium, sponsored by the Group on Sonics and Ultrasonics of the Institute of Electrical and Electronics Engineers, Hotel Sheraton-Boston, Boston, Dec. 1-3.

Sixth Annual Symposium on Filament Structures Technology, sponsored by the American Society of Mechanical Engineers, New Mexico Section and the University of New Mexico, University of New Mexico student union building, Albuquerque, Dec. 3-4.

NSIA/AFSC Microelectronics Conference on "Applications of Microelectronics Technology," sponsored by the National Security Industrial Association and the Air Force Systems Command, Sheraton-Park Hotel, Washington, D.C., Dec. 8-9.

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The Next Step

ONE OF THE MOST PROMISING aerospace programs now under way is the effort to apply the industry's knowledge in systems management and advanced technology to the nation's major socioeconomic problems.

The state of California has led the way in this field with its financing of four study efforts by aerospace firms on such state problems as waste management, crime, information-handling and transportation.

We have, in the past, devoted considerable editorial attention to the California experiment because we believe it holds a large potential for the industry as a future market—and as a useful, additional contribution to the nation from the money spent on space and defense programs. Our West Coast bureau chief, Bill Wilks, is undoubtedly more knowledgeable in this area than any other reporter in the industry, or indeed in the general press. We believe we can also state, albeit immodestly, that we are the only industry publication to devote such attention to this topic.

It is with interest, therefore, that we mark two recent developments in connection with the California studies.

As a direct outgrowth of the California program, Sen. Gaylord Nelson (D-Wis.) has introduced a bill to authorize a $125-million, five-year program for contracts which would develop new techniques in applying space-age know-how to the nation's social and economic problems. In introducing his bill, Sen. Nelson asked a number of interesting questions. Among them:

Why can't the same specialist who can figure out a way to put a man in space figure out a way to keep him out of jail? Why can't the engineers who can move a rocket to Mars figure out a way to move people through our cities and across the country without the horrors of modern traffic and the concrete desert of our highway system? Why can't the scientists who can cleanse instruments to spend germ-free years in space devise a method to end the present pollution of air and water here on Earth?

The answer, as Sen. Nelson pointed out, is that we can—if we have the wisdom to do so. His bill would authorize the Secretary of Labor to contract directly with private firms, universities and non-profit institutions—and with states or groups of states—to study the use of systems analysis and systems engineering for a broad range of local and national problems.

The Wisconsin senator frankly acknowledges that his bill is an attempt to build upon the first steps taken by the state of California. We hope that the Administration and the Congress recognize the importance of what California has done and what the industry has to offer in this field. Sen. Nelson's program would provide a necessary second step from the California beginnings.

For one thing, a Federal contribution to the West Coast effort initiated by Gov. Edmund G. (Pat) Brown is warranted in order to help the state continue a program which will serve as a national model. Secondly, it will encourage such efforts elsewhere—an important aspect since many of the problems under investigation are, from a systems viewpoint, national in scope. The California results are most encouraging. Now, further impetus is needed. Sen. Nelson's bill provides that impetus.

THE SECOND DEVELOPMENT of interest came just last week when the Washington region of the Aviation/Space Writers Association took the unusual step of devoting its monthly meeting to the California experiment. Despite the fact that the subject was neither aviation nor space, the turnout was exceptional.

One of the most interesting reports to the group pinpointed how systems analysis can prove of immediate value when applied to state problems. Space-General Corp., in its crime study, analyzed 100 areas in Los Angeles to determine potential trouble spots by means of five parameters—maximum crime rate, maximum school drop-out rate, median income lower than $5,000, maximum population density and highest percentage of a minority group. As dramatically illustrated by the overlays of the report, only one Los Angeles district achieved the dubious distinction of being at the head of the list for all five. Named in the report, which was submitted a month before the outbreak of the Los Angeles riots, that district was, of course, Watts.

Systems analysis certainly cannot spotlight all problems as quickly. But an apt example of what the lack of it can mean to a state was cited by Space-General's James Rowe. Dredging of the Sacramento River to allow ocean-going vessels to reach the state capital has resulted in a slowing of the river's current which has created a major pollution problem due to the growth of algae.

As Mr. Rowe commented, "Someone didn't look at the problem from a systems viewpoint."

Lockheed Missiles and Space Co. has found that a computerized data-handling system has cut wastage in the two-county Alameda-Contra Costa bloodbank from the national average of 18% down to 6%.

North American Aviation, with probably the most ambitious assignment of all in undertaking a look at the state's transportation problems, has come to the conclusion that even today's technology makes possible the 500-mph tube trains, 150-mph surface effects ships, ground effects machines and V/STOL craft which could operate in a transportation system of tomorrow.

But as North American pointed out, transportation is not solely an intra-state problem—any more than are crime, pollution or the flow of information. It is, therefore, time for the Federal Government to join the California experiment, as Sen. Nelson has suggested.

William J. Coughlin

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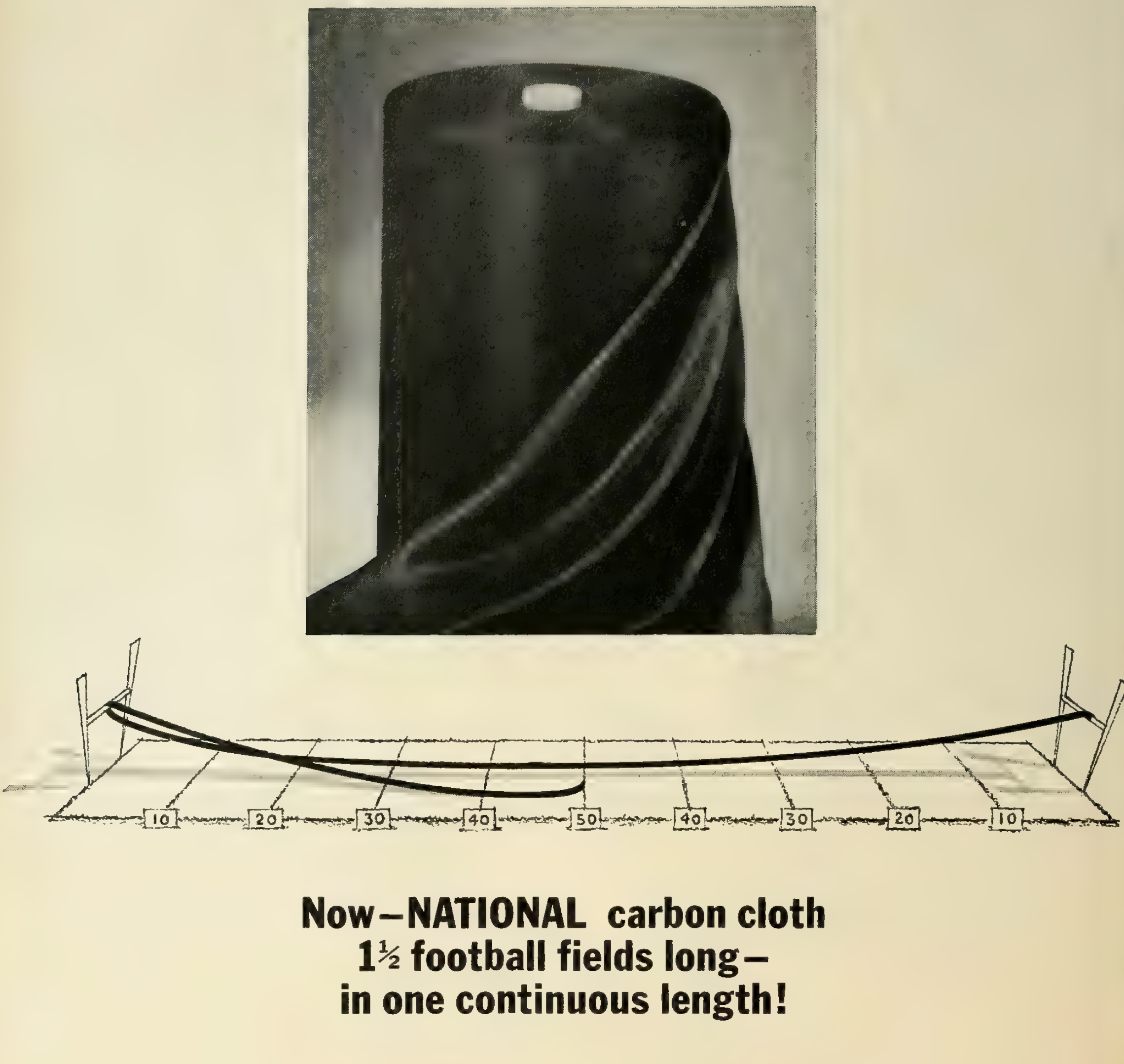

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THE COVER

Air Force experimental stellar-inertial guidance equipment was successfully flown from Cape Kennedy Nov. 12 using a Polaris A-1 booster. Success of Stellar Acquisition Feasibility Flight (STAFF) improves chances for continued development funding for the system. See p. 15.

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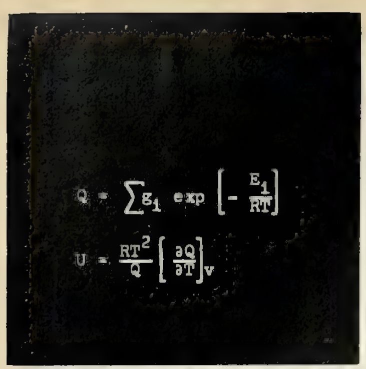
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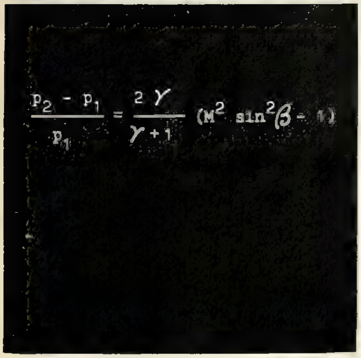
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letters

MSFC and Nuclear Stages

To the Editor:

In an article entitled "Von Braun Urges Reusable Transport" (M/R, Nov. 8, p. 16), I was credited with making the statement that Marshall Space Flight Center is studying the employment of nuclear-powered first stages for a post-*Saturn* reusable launch vehicle.

This statement could only have been the result of a poorly constructed sentence on my part or a misunderstanding or misinterpretation on the part of the correspondent. What I am convinced I said in connection with possible post-*Saturn* launch vehicles was that we are considering a ramjet or liquid rocket first stage or stages with a nuclear final stage. My remarks regarding application of the nuclear engine were limited to possible employment in vehicles launched from Earth orbit and as a third stage of *Saturn V*.

You understand, I know, how long we have been discussing and studying the subject of nuclear reaction engines. Nothing that we have produced would cause me to advocate use of a nuclear stage for a booster in the foreseeable future.

Lest my peers believe that I have gone way, way out, I would appreciate anything you can do to correct the impression created by the article in question.

Wernher von Braun
NASA Marshall Space Flight Center
Huntsville, Ala.

STL and Surveyor

To the Editor:

By and large, I find your editorials refreshing, quite challenging and factual. However, the Nov. 1 editorial ("To the Moon, Softly") in my mind was misleading, largely through omission rather than commission.

I refer specifically to the statement "STL ran into difficulties." To set the record straight, it should be recognized that from April, 1963, to December, 1964—before the time period described in the editorial—TRW was under contract to JPL to develop an engine using an ablative thrust chamber and a unique variable-area injector concept. Progress was so marked that in July, 1963, we were assigned the role of backup engine contractor, and it was suggested that because of its growth potential our engine might be used on the Block II *Surveyor.*

By July, 1964, with considerable testing experience behind us, JPL decided that the RMD contract should be cancelled for Block II and that our role in the Block I program would be elevated to that of an alternate. Later, the JPL project office conducted a thorough analysis of various engines and feed-system configurations. Included in the analysis was the RMD engine, which, as a result of an accelerated company-funded engineering effort, was considerably modified. It was concluded that an earlier test flight could be achieved with the modified RMD engine because integration of this engine was easier and much system testing had already been done with the rejected model. Thus, the decision was made to reorient the TRW contract to cover a limited pre-qualification program. This program was successfully completed in December, 1964, and TRW received letters of commendation from the JPL project officials. The actions described occurred during the four-month period cited in your editorial and in the (House) Space Committee report.

I trust that this correction will set the record straight and clarify the technical validity of our engine. The two years of work for *Surveyor* had many benefits, not the least of which was proving our concept, which has since been expanded and is now being used in the development of the engine that will soft-land our Project *Apollo* astronauts on the Moon.

Robert Bromberg
Vice President
Director, Mechanics Division
TRW Systems
Redondo Beach, Calif.

Principle of Uncertainty

To the Editor:

Responsive to the Oct. 18 editorial ("Hardly a Time for Complacency"), Nature knows no favorites; and Time is directional as a multiple of thermodynamic energy resulting from changes in the state or phase of electrons, atoms, or molecules traversing space; of which temperature is a state of energy associated with the directional movement of electrons, atoms or molecules in space-time.

Prof. Heisenberg's uncertainty principle simply means that a static point in space-time is not resonant with the directional flow of thermodynamic pulses generated by electrons, atoms or molecules traversing space in time; and the lack of resonance inherent in the interference of the time constant of the U.S. space program will result in an undesirable variant in time. An example of this phenomenon is illustrated by *Luna 7's* failure due to misfiring of the retro-rockets. The injection of ionized plasma from the solar wind into the Earth's magnetosphere alters the intensity of ionization of the ionospheric layers, with consequent storm-time variations and changes in radio absorption characteristics which prevent correct timing for firing retro-rockets in response to signals from Earth.

Harry Bricker Fuchs
Farmingdale, N.Y.

Stock Upswing

To the Editor:

I was interested in your Nov. 15 report on the spectacular upsurge of missile/space stocks on Wall Street. It would be idle to attempt to deny that most of the boost has come from the Vietnam war, but it is apparent that the space race has contributed.

John Pappas
Newark, N.J.

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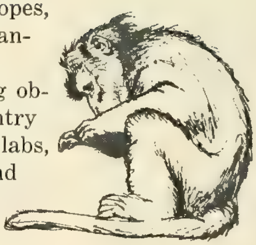
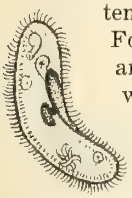


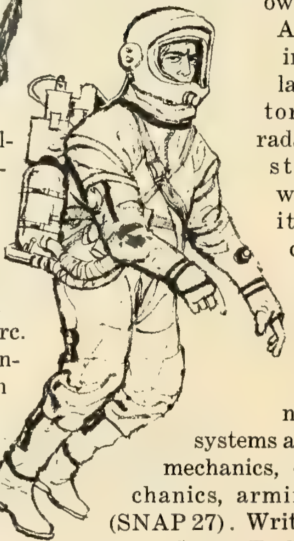
Monkeys, astronauts, telescopes, sea urchin eggs and tradescantia come in the front door. Weather satellites, orbiting observatories, ballistic re-entry systems, manned orbiting labs, biosatellites, space taxis and space buses go out the back.

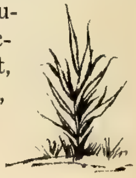
Mark 2 and other vintage re-entry systems are in the Smithsonian (we're now developing advanced ballistic and return-from-orbit re-entry systems). Nimbus flew out of our Valley Forge space simulators a year ago and faced the world. At one extreme we built a 15-part Gravity Gradient Stabilization System which is still operating within 4½ degrees of arc. At the other, our 22,000 part control system for OAO will soon have its chance to hurtle a Mt. Palomar through space.



Biosatellite with its lively "crew" is slated for several round-trips soon. MOL and its astronauts will see the countdown a couple of years later (recently selected as a prime contractor). We're studying unmanned exploration of Mars (Voyager). Our SNAP 27 will be the first nuclear power system to hit the moon.

And we have a lot of ambitions that are yet ideas. Space shuttles and space station taxis, for example. No wonder our engineers always buckle down (their own test benches may go up next).





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The Countdown

WASHINGTON

U.S., USSR Maneuvering Race

Latest in the recent string of Soviet weapons claims is a statement by Gen. Vladimir Tolubko in a Tass interview that the USSR is developing ICBM's that can maneuver on trajectory. This comes at a time when the U.S. is known to be making final preparations for test-flights of maneuverable re-entry vehicles for ICBM's. It also comes just a few weeks before the Administration is expected to announce a decision on the future of the *Nike-X* anti-ICBM system (COUNTDOWN, Oct. 25, p. 9). While maneuvering capability is important, the main development effort on both sides of the Iron Curtain is believed to be directed toward systems that can evade any future missile defense. Type of defenses projected also determines whether warheads must be made to maneuver inside or outside the atmosphere, or both.

Twin Satellite Launch Due

NASA plans to launch two satellites with a single *Thor-Agena B* booster this week from the Western Test Range. The satellites—Canada's *Alouette 2* and the space agency's Direct Measurements *Explorer*—are part of the international program of ionospheric studies.

A Titan Defeated by Gemini

Potential conflict with the scheduled *Gemini 7* launching from Cape Kennedy on Dec. 4 has caused rescheduling of the next Air Force *Titan III-C* shot from Dec. 2 to Dec. 21. The *Titan* launch will be the first from the new Pad 41 at the AF complex and will also be the first to fully exercise the Integrate-Transfer-Launch (ITL) concept around which the program was developed.

Little Joe Apollo Escape Test Deferred

Last launch of the *Little Joe 2* booster in a maximum-"Q" abort test of the *Apollo* escape system has slipped from Dec. 1 to about Dec. 8. No reason has been given for the delay. If further slippage creeps into the program, the shot could be delayed until next year—the White Sands Missile Range closes down for two weeks for the Christmas holidays.

First Dockable Apollo Slated for Saturn IB

First Block II *Apollo* spacecraft will go aboard the seventh flight in the *Saturn IB* series. The Block II *Apollos* will be the first in the family to have docking capability.

Space Power Satellite Plan Foiled Again

Officials of NASA's Office of Advanced Research and Technology, who have been pushing for years for a space-power technology satellite, have been frustrated again, Their latest effort, during discussions of the Fiscal Year 1967 budget, failed when top-level planners knocked it out of the agency request.

ESD Joins Vietnam Liaison Move

Air Force's Electronic System Div. has set up a high-priority Limited War Office to tie into the command-wide organization being established throughout AF Systems Command (M/R, Oct. 25, p. 10) to improve liaison on Vietnamese operations and problems. Coming back from Vietnam to head the office will be Col. Paul L. Deimling, an ESD deputy for surveillance and control systems.

INDUSTRY

Non-Profit Report Expected Within Month

The committee established by the Air Force to investigate the use of non-profit organizations reportedly will make its findings and recommendations known to AFSC commander Gen. Bernard A. Schriever about Dec. 21. In one committee staff change, Martin Marietta Corp.'s Malcolm MacIntyre has been replaced by Tom Jones, president of Northrop Corp.

DOD Tracking Down Leak on C-5A Award

Pentagon officials are attempting to find out just who leaked information on the C-5A cargo aircraft contract award, sending Lockheed stock soaring just before the official announcement. Secretary of Defense Robert S. McNamara said in a letter to Rep. Bob Dole (R-Kan.) that he was concerned over the impact that the word of such an award can have on Wall Street.

Westinghouse Testing Deepstar Submersible

Westinghouse Electric Corp. has begun deep-diving tests of its three-man Deepstar 4000 submarine at San Diego. The 9-ton, 18-foot-long vessel is expected to reach its maximum operational depth of 4000 ft. before completion of testing in about a month. It will skim along the ocean surface and be capable of stopping, backing and hovering. Its crew will ride in a 6½-ft.-dia. sphere of high-strength, pressure-resistant steel 1.2 in. thick. Navy Electronics Lab in San Diego is negotiating with Westinghouse to lease the vehicle for its deep-submergence research program after certification tests by the Bureau of Ships. Westinghouse envisions Deepstars capable of dives to 20,000 ft. within three years.

INTERNATIONAL

Germany Picks Firm to Manage Satellite

Gesellschaft für Weltraumforschung (GfW) has been selected by the West German Ministry for Scientific Research to manage the German Project 625A scientific satellite program. Under an agreement signed by West Germany and NASA in July, the satellite will be used in a cooperative investigation of the Earth's inner radiation belt. Plans are to launch it into a polar orbit in 1968, using a U.S. *Scout* booster.

French Satellite May Use Russian Booster

A recent visit in France by a delegation of Soviet space scientists has been followed by a statement by Russian Prof. Leonid Sedov that the group proposed to the French that the latter use a Russian launcher to put a French satellite into an eccentric orbit. French experts have refused to reveal anything about the discussions, noting that they were not on a government level and that there are problems to be solved before any such cooperative project could materialize. One such problem would be affording French technicians access to Soviet launching bases.

ATS To Go Sans Ion Engine

NASA plans to launch the first *Applications Technology Satellite (ATS-B)* as scheduled late next year, but will not include its ion engine station-keeping experiments.

Robert J. Darcey, *ATS* project manager at Goddard Space Flight Center said that because the 6-lb. device would not be ready in time, it will be slipped to the flight of the *ATS-C* spacecraft. This launch is now scheduled for late 1967.

Apollo Test Delayed

Apollo 009, scheduled for launch aboard a *Saturn IB* early next year, is to undergo two tethered test firings of the Service Module's propulsion system as soon as a fueling problem can be solved.

The engine, an Aerojet-General AJ10-137, was to have been fueled Nov. 13 for static firing Nov. 15, but during internal cycling tests in ground equipment, particles were discovered in the nitrogen-tetroxide oxidizer. The trouble was discovered before the fuel was pumped into the spacecraft. However, a change in filters early last week did not solve the contamination problem and caused the test, which had been re-scheduled for the 17th, to slip again.

The engine is to be fired for 15 seconds, shut off for two hours and restarted for another 15-second burn at Launch Complex 16.

The Command Module is currently at the hypergolic building on Merritt Island for environmental control subsystem servicing and checkout of the electrical power subsystems. The Service Module will be mated to the Command Module in the manned spacecraft operations building high bay area. The two modules will be checked on a polarity fixture which rocks the spacecraft off center in a test of spacecraft reaction control subsystem jets to correct attitude.

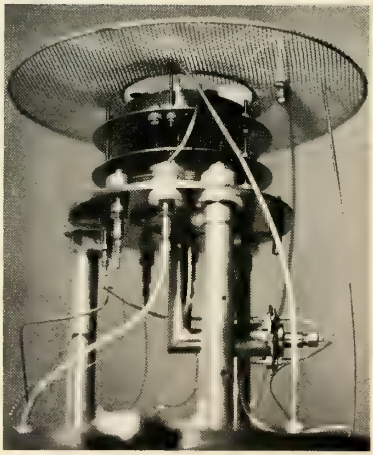
Following integration checks, the service propulsion system engine will be installed and spacecraft *009* transferred to pad 34 for mating with its *Saturn IB* launch vehicle. At the pad, more integration checks will be run—this time with spacecraft and booster—and electrical mating will be accomplished before the final countdown demonstration and flight readiness tests.

Apollo 009 is the first fully instrumented spacecraft, complete with all subsystems except a guidance and navigation subsystem and fuel cells and their supporting cryogenic subsystem. The unmanned capsule is also equipped with a programmer to simulate astronaut reactions. Primary purpose of the flight will be to check mechanical compatibility of the *Apollo* with its booster, and to test the spacecraft heat shield in a high velocity re-entry mode.

Little Joe 2 Resting Well

A guidance control system for the *Little Joe 2* booster was released from a Las Cruces, N.M., hospital in satisfactory condition Nov. 11 following emergency X-ray treatment.

White Sands Missile Range technicians working on the booster in preparation for an *Apollo* escape system test scheduled for Dec. 1 took the guidance unit to the hospital after they failed to determine the cause of a malfunction in the system. Industrial X-ray facilities at White Sands were closed for Veterans Day.



French Fire Electric Engine

ENGINEERS at the French National Office for Aerospace Studies and Research (ONERA) have operated a mercury ion engine for 100 hrs. at simulated altitudes of 180 km. The test was deliberately limited to 100 hrs. and used a unit similar to the engine shown above. A mercury mass-flow rate of 70 micrograms/sec. ejected at a velocity of 51 km./sec. with a power of 250 watts—resulting in a thrust level of 0.2 gram. Sputtering was moderate, and the design is being considered for space use.

Martin Gets Nimbus Generators

Martin Co. will build two pairs of radio-isotope-fueled nuclear generators for NASA's *Nimbus-B* weather satellite program.

Work will be done under a $2.4-million contract extension awarded by the Atomic Energy Commission. One pair of the 30-watt generators will be on board the *Nimbus-B* satellite when it is launched in 1967. The other pair will serve as a back-up. *Nimbus-B* will be the first meteorological satellite to use nuclear power.

The contract extension also calls for production of additional unfueled and electrically heated generators for system qualification and reliability testing.

Soviets Launch Venus Probes

The Soviet Union now has two spacecraft headed toward exploration of Venus.

The launch of *Venus 3* was announced on Nov. 16, only five days after the launch of *Venus 2*. News reports from that nation said that *Venus 2* would reach the vicinity of Venus about the end of February.

Thus far, there has been no indication as to whether *Venus 2* or *3* will fly-by the planet or crash into its surface.

The only other announced Russian Venus mission, *Venus 1*, failed when its radio went silent. It missed the planet by 100,000 miles. U.S. officials report the Russians failed in at least six other attempts to explore the planet.

Evvard Gives Propulsion Views

"We'll be lucky if we have nuclear propulsion around 1980," and electric propulsion is still further down the line for sometime after 1985, according to Dr. John C. Evvard, deputy associate director for research at NASA's Lewis Research Center.

His views on electric propulsion thus appear to be in conflict with joint Air Force-NASA feasibility studies that indicate such systems could compete with chemical propulsion for many interplanetary missions in the early 1970's (M/R, Nov. 8, p. 40).

Evvard gave his views on advanced propulsion systems last week while speaking to the sixth annual Space Technology Series sponsored by the Canaveral Section, Institute of Electrical and Electronics Engineers, at Brevard Engineering College, Patrick AFB, Fla.

A pioneer in electric propulsion and advanced nuclear rocket studies, Evvard believed such concepts should not be considered for Mars missions of under 100 flights per year. Only frequent flights would increase the need for higher specific impulse and would justify the expense, he said.

Meanwhile, he predicted, chemical rockets of less than 500 seconds specific impulse will lift men to Mars, not by direct ascent but through a succession of parking orbits and assembly of hardware in space. Evvard told the meeting that since May 13, 1964, at least nine tests on Kiwi, Nerva and Phoebus nuclear reactors, have proved out a thrust greater than 50,000 lbs. at a specific impulse in excess of 750 seconds.

The NASA scientist described three nuclear reactor types and plainly favored the heterogeneous thermal reactor. Turning his attention to electron bombardment engines, he said the most promising are two versions of the Kaufman engine, one using mercury and being developed at Lewis, the other using cesium and financed by Lewis for development by Electro-Optical Systems. The flight version of the engine being developed at Lewis will have a thrust of 0.007 lbs. and specific impulse of 5,000 seconds.

A drawback of electrical propulsion, however, is that an electrical power plant must be carried with the electric engine, thereby increasing the system weight to the point where there is more weight to be pushed than ability to push it. The high system weight of electric engines restricts their use to deep space travel, and much research is being directed toward development of lightweight, efficient space nuclear power supplies.

"Before we get enthusiastic about nuclear rockets, we must have a fuel weight two to three times the weight of the reactor and heat shield," Evvard said. The scientist presented schematics of various electrostatic, electromagnetic and electrothermal engines and discussed their relative merits and performance potential.

Shots of the Week

The fourth and final flight of the *Stellar Acquisition Feasibility Flight (STAFF)* program from Cape Kennedy aboard a Navy-supplied *Polaris A-1* ICBM Nov. 12 was termed an unqualified success by the Air Force and General Precision, Inc. GPI makes the *STAFF* guidance system, intended as a forerunner of a Stellar Inertial Guidance System (STINGS) (p. 15).

- The Air Force launched three high-altitude research rockets from Eglin AFB, Fla., Nov. 9 and 10. An *Honest John-Nike-Nike-Hydac* carried a 250-lb. payload to an altitude of 326 mi. on the 9th; on the 10th, two International Quiet Sun Year launches, one employing a *Nike-Cajun* and the other, a *Sparrow-Arcas*, were made simultaneously in support of one another.
- The Soviet Union on Nov. 12 and 16 launched two instrumented space craft, *Venus 2* and *Venus 3*, toward Venus (see item, p. 10).
- An Air Force *Hound Dog* missile crashed shortly after launch from a B-52 aircraft, Nov. 12 over Ft. Wingate, N.M., some 175 mi. from its target in White Sands Missile Range, N.M.

Carpenter Wins Legion of Merit

Astronaut Cmdr. M. Scott Carpenter has been awarded the Legion of Merit for his work in the Sealab II program (p. 28).

The other team captain in the underwater experiment, Chief Petty Officer Robert Sheats, received the Legion of Merit last month.

Lunar Dust Dangers Pondered

Jet Propulsion Laboratory scientists say new studies suggest that, if it is dust, the lunar surface may collapse catastrophically when contacted by rocket exhausts or other contaminants.

JPL scientists working on the topic suggest measuring the particle size of lunar dust by Earth-based laser measurements, so that "landing areas could be intelligently selected." If the particle size is known, even to only an order of magnitude, the likelihood of gas-induced collapsed and the approximate bearing strength of the surface can be estimated, reports B. G. Moser, R. E. Wiech, Jr., and R. F. Landel, all of JPL.

The possibility that rocket exhausts could lower the surface energy of lunar dust particles was put forward by Professor Harold Urey. What happens then depends on particle size. If it is small enough for the dust layer's behavior to be dominated by surface-energy forces, the surface will collapse into a crater.

The particle sizes of interest are microns and tenths of microns. Existence of atmospheric windows at the corresponding wavelengths gives the possibility of laser measurement of particle size, says the JPL team.

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Finger Cites Thermionic Power Gains

Space nuclear boss tells Atomic Forum work on devices for in-core reactor uses is going well; other highlights of nuclear progress report

by William S. Beller

EXTRACTION OF ELECTRICITY from thermionic diodes within the core of a nuclear reactor is proving feasible. The *Apollo* experiment package will be energized by 50 watts of nuclear-derived power. First flight-configured nuclear rocket will be tested in 1967.

These were the highlights of the nation's nuclear space program outlined by Harold B. Finger, Atomic Energy Commission-NASA space nuclear chief, to the Atomic Industrial Forum Twelfth Annual Conference, held last week in Washington, D.C.

- **Space reactors**—Finger revealed that work on thermionic devices for in-core reactor applications "has been proceeding well and is now beginning to accumulate significant operating time in in-pile testing." This is the first public release of information relating to the success of in-pile work, although rumors of such achievements have surrounded the work of several AEC contractors.

Finger told of the in-pile work in relation to the liquid metal-cooled reactor work at Lawrence Radiation Laboratory. This is follow-on work to SNAP-50, which is nearly finished. The present work "is directed at trying to determine how to build the highest-temperature reactor system that could lead to high power in the lightest-weight and longest-life package."

These high-temperature reactors possibly could be used with Rankine-cycle conversion equipment despite the experiences with SNAP-50, high-temperature Brayton cycle equipment, or, "if thermionic element power density increases significantly at reduced temperatures, with out-of-core thermionic devices," says Finger.

- **Isotope power**—Isotope systems are expected to play the major nuclear power role in space long before the nuclear reactor gets off the ground. SNAP-19, developed as an experimental power source for the *Nimbus-B* mission, is scheduled to fly in 1967, according to Finger. It is a 30-watt, plutonium-238-fueled unit. Current plans call for the SNAP-19 system to be burned up on re-entry in order to avoid any fallout on a civilian population.

Finger gave some of the first details on the SNAP-27 isotope system, under development to power the *Apollo* Lunar Surface Experiments Package (ALSEP), which astronauts will deposit on the Moon during early flights. The isotope unit will deliver 50 watts and be fueled with plutonium-238.

Finger pointed out that no other power system is being developed for this application and "the three study contractors now working for NASA on the design of the experiment package have been instructed to mate their experiments with the power system." He hailed this technique as a major step forward and "the first time . . . a space payload and an isotope power supply are being designed concurrently to fit each other rather than trying to integrate the isotope power system into an existing spacecraft."

SNAP-27 was described as the first isotope power development program incorporating all the management control procedures, reliability apportionment and assessment procedures, quality assurance, detailed environmental testing, and flight qualification testing to ensure a high probability of success of the finished product.

"The one weakness in this program is the short time available for the development," complained Finger. Striking at the well-known "requirements merry-go-round," Finger said this weakness demonstrates the importance of proceeding into development of advanced hardware "before firm mission requirements must be specified."

- **Advanced isotope power**—Development of advanced systems using isotope power is getting increased attention from the Dept. of Defense, as well as NASA and the AEC. Finger outlined areas in which systems studies are now going on, as initial phases of development activities:

—A 250-300 watt generator fueled with plutonium-238, or with strontium-90, if ground checks do not raise safety problems.

—A design study of a relatively high-powered polonium-210-fueled generator; requested by DOD, the study may lead to a unit applicable to a wide range of NASA and DOD manned missions, such as advanced applications where logistic requirements would permit power-supply refueling.

—Kilowatt-size isotope heat sources that could generate from one to ten electrical kilowatts, depending on power conversion system. Plutonium-238, curium-244 and polonium-210 are under consideration.

—Technology work on isotope-thermionic units.

Using funding as a measure of potential need, Finger noted that the isotope program in AEC's Space Nuclear Systems Div. has grown from about $3 million spent in Fiscal 1965 to over $8 million in the Fiscal 1966 budget.

- **Nuclear rocket**—Within the next few weeks, a breadboard of the NERVA reactor engine will undergo its first ground test. Although not arranged in flight configuration, it will nevertheless be "a self-contained, self-sustaining, booststrap start, engine test system," according to Finger.

The next phase of engine checkout will begin in early 1967, when the first ground experimental engine with components more closely approximating the flight system goes into test. ■

Welsh Blames Planners For Nuclear Rocket Lag

NUCLEAR ROCKETS have suffered in development by ignorance and "lack of imagination" on the part of space planners, charged Dr. Edward G. Welsh, Executive Secretary of the National Aeronautics and Space Council, at the joint meeting of the American Nuclear Society and Atomic Industrial Forum.

He saw "no alternative" to nuclear energy for the high-power space missions coming up a decade or so hence. These include manned and unmanned interplanetary flights, large lunar bases, sophisticated comsats, and military reconnaissance space orbiters.

Welsh decried the fact that the flight test of a nuclear rocket has not only not been scheduled but no money has been sought for the experiment. He noted that persons responsible for such decisions say that no requirement for the rocket exists.

"If we wait for precise missions definitions, the technology will not be here when it's needed," said Welsh. He added that the Soviets will not be so lax.

AF Seeks Tests to Requalify Agena

Wind-tunnel series at Tullahoma, which would last four months, must win NASA approval; plan would defer space-docking schedule

by Hal Taylor

AIR FORCE SPACE SYSTEMS Division wants to run a four-month series of wind-tunnel tests in order to requalify the *Agena Gemini* target vehicle.

If approved by NASA—which wants to cut the testing to only two months—the Air Force plan would put the first U.S. space-docking flight off until late in the second quarter of next year.

The series of tests would not begin until Dec. 24 at the Arnold Engineering Development Center, Tullahoma, Tenn. NASA's permission had to be requested because the wind tunnel at the facility is currently being used to test engines for the *Apollo* spacecraft's Lunar Excursion Module.

The test series is part of the Air Force's and space agency's continuing effort to determine what caused the *Agena* to blow up on the October 25 *Agena 6* flight and what modifications are needed to prevent a recurrence.

A NASA/Air Force flight safety review board recently said that the most probable cause of the failure was a hard start of the primary propulsion system. This could have been caused when oxidizer rather than fuel was injected into the thrust chamber.

The late start on the wind-tunnel runs results from the need to modify the *Agena 5001* vehicle—now at Cape Kennedy—so that it can serve as the *Gemini* target test vehicle.

If the wind-tunnel runs should indicate that modifications are required to solve the *Agena* problem, NASA officials say, the changes will be made simultaneously on the target vehicle which will be used during the *Gemini 8* flight.

The systems division is running the test series because it developed and procures the *Agena* vehicle for the space agency. Exactly how long the tests will last probably will be determined in the next few weeks, after discussions between officials of both groups.

If the test runs the full four-month period which the Air Force wants, the *Gemini 8* flight will be delayed until late May or June.

- **GT-6 primary**—In another *Gemini* program development, the space agency announced that its flight controllers will monitor only one *Gemini* spacecraft in real-time during the dual *Gemini 7-Gemini 6* mission next month.

"While *Gemini 6* is up, it will be the primary spacecraft," said William E. Platt, assistant flight director at Mission Control Center.

IBM 7094's at the Control Center and Univac 1218's at remote tracking stations will be loaded with *Gemini 6* programs and digital data from *Gemini 6* will be flowing into these computers. This will enable remote sites to send summary digital data via teletype to the center to keep various digital displays in Houston updated.

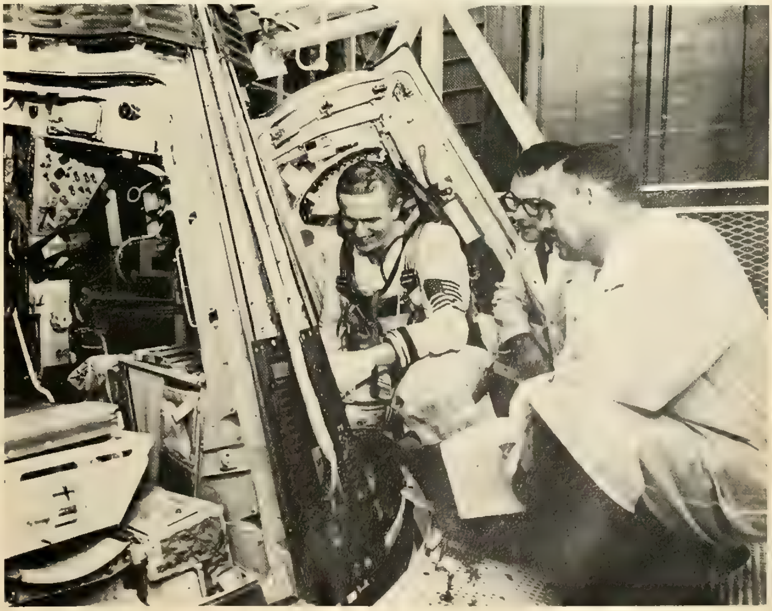
When both vehicles are within range of the same tracking station, data from both can be displayed simultaneously at that site by patching one spacecraft into the *Agena* console. *Gemini 7* data will be recorded at remote sites and sent to the MCC after *Gemini 6* data has been processed and sent in real-time.

Of three frequency-modulated telemetry transmitters onboard each spacecraft—real-time, delayed time (for telemetry data dump), and stand-by—one spacecraft will transmit its real-time digital telemetry data on the real-time transmitter, and the other will send its real-time data on the stand-by transmitter on a different frequency. Data dumped approximately once each orbit by each spacecraft will be tagged with the spacecraft's identity. Each spacecraft will dump stored data either at different stations or at the same stations but at different times.

- **Voice communications**—The voice transmissions between the two orbiting spacecraft and between the vehicles and ground stations will be shared on a common frequency, Platt said. Each transmission will be preceded by spacecraft identification to prevent confusion.

Ground commands to the spacecraft through the Digital Command System (DCS) will most likely be resolved "procedurally." Real-time commands for executing on/off switching of C-band transponders or telemetry tape transmitters, and "stored" commands for setting the retro-fire clock or for updating data in the on-board computer may be sent only to *Gemini 6*, while *Gemini 7* performs all of its functions manually. To prevent commands from entering *Gemini 7*, in such a case, "we

GEMINI 7 astronaut Frank Borman (left), command pilot for 14-day orbital mission, and McDonnell executives check spacecraft interior at Cape Kennedy.



would advise *Gemini 7* to turn off all affected circuit breakers prior to our commanding *Gemini 6,*" according to Platt.

"We still don't know how we will go on this," he said. Doctors have required that both pilots sleep at the same time and the manual procedure required of *Gemini 7* pilots "may interfere with their normal sleep cycle."

C-band transponders on board each spacecraft will be interrogated by ground radar for determining spacecraft ephemeris, or orbital position versus time. While both spacecraft will be using the same frequency, received data will be readily identifiable in that it will *look* different, he said. Returned pulses from one spacecraft will be spaced differently. "We may set the spacing three microseconds on one, and five microseconds on the other," he said.

- **Double tracking**—Plans call for *Gemini 7* to circularize its orbit about the third day before the *Gemini 6* launch, he said. "We will be tracking *Gemini 6* because it will be changing its orbit during maneuvers toward *Gemini 7,* while *Gemini 7's* orbit will be pretty well defined by this time."

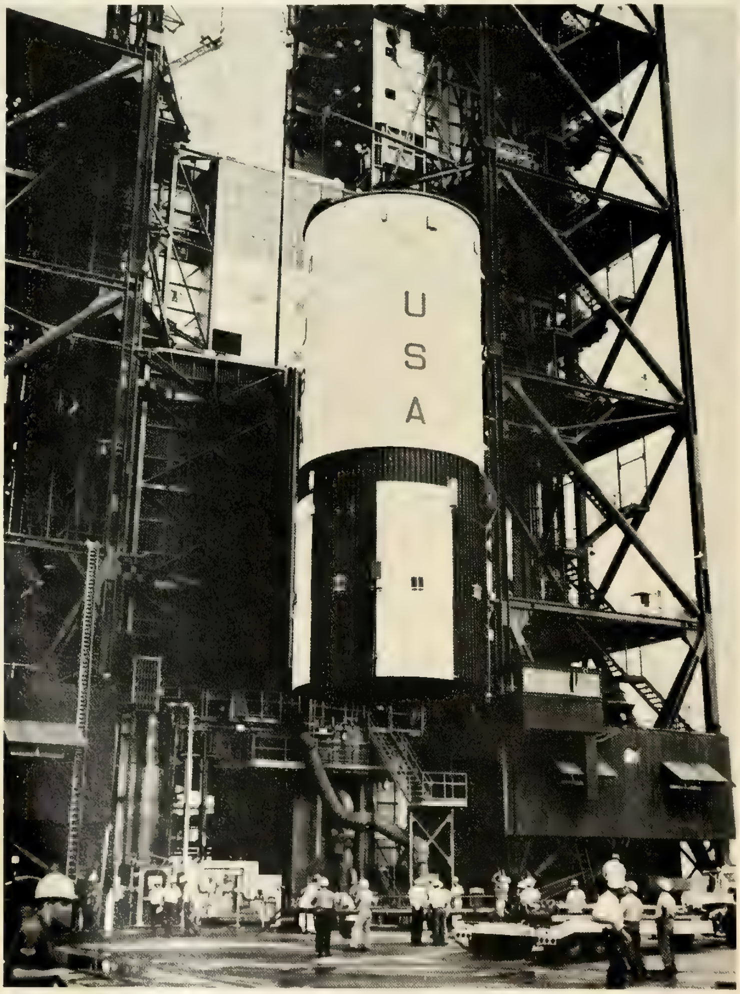
While both vehicles are close together and over a tracking station, ground radar can obtain some data points on each vehicle simply by switching to the appropriate C-band code. ■

MSC Plans First Manned Chamber Tests Soon

NASA's MANNED Spacecraft Center has begun man-rating its $35-million space environment facility at Houston, Tex., and first manned tests inside the 43-x-35-ft. chamber are scheduled for early in December.

MSC engineers hope to begin man-rating the larger chamber—120-x-65 ft.—early next year.

First manned tests in the smaller chamber will be to qualify a special version of the *Gemini* extravehicular spacesuit. Richard J. Piotrowski, who is in charge of man-rating the two huge chambers, said that a test subject will wear the suit with the Astronaut Maneuvering Unit (AMU)—a rocket-powered backpack to be worn by Charles Bassett during the *Gemini-Titan-Agena 9* mission next year. Backpack thrustors will be fired inside the chamber to study plume impingement effects on the spacesuit, he said.



FURTHER APOLLO PROGRESS—Saturn IV-B stage goes up at Cape Kennedy.

Piotrowski said that the smaller chamber will also be used by astronauts for checking out mission operation procedures. A full-scale Lunar Excursion Module (LEM) will be placed inside the chamber "by late 1967."

Meanwhile, full-scale Command and Service Modules will be moved inside the larger chamber early in 1966 to support the first manned *Apollo* flight, he said. M/R earlier learned that this first manned mission is *Saturn-Apollo 204,* scheduled for October, 1966.

The chamber will duplicate Earth-orbital conditions (except for zero-gravity) and with man in the loop (personnel will be enclosed within the spacecraft) tests will verify systems operation in a vacuum and under extreme temperatures. Carbon arc lamps at the top of the chamber will radiate "solar" heat and liquid nitrogen panels surrounding the test article will provide engineers with temperatures ranging from —280° to 280°F for space simulation. Both chambers can be pumped down to 70-n. mi. altitude, Piotrowski said.

A full-scale *Apollo* spacecraft, including the LEM, will be placed inside the large chamber about three months prior to the first Block II *Apollo* mission, he said.

Navy To Brief Industry on FDL Ships

Aerospace procurement concepts to be tried; December briefing is scheduled; interest runs high in rapid cargo-handling project

by Michael Getler

THE NAVY WILL HOLD an unclassified briefing for industry in Washington in mid-December concerning its plans for development of the newly approved Fast Deployment Logistics (FDL) ships.

It says the briefing will cover the project concept, a description of the ship system, the planned acquisition process, and the use of the "total package" procurement concept which is being applied for the first time in development of Navy ships.

Exact time and location of the briefings is expected to be announced imminently.

The program has caused considerable interest within the aerospace industry, since the way in which the ships will be contracted reflects the first attempt by the Navy at using the long-standing practices of industrial design, development, and production applied to aerospace hardware evolution for several years.

• **Admirals protest**—The project also has aroused wider interest than is normal for a program of this nature, primarily because adoption of the so-called "Air Force approach" to aircraft development in the ship construction area was cited earlier this month as one of the reasons behind the resignation of two top Navy admirals, Rear Adm. William A. Brockett, Chief of the Bureau of Ships, and his Deputy Chief, Rear Adm. Charles A. Curtze.

The admirals reportedly felt strongly that going to industry for basic design of Naval ships is a mistake. They are alleged to have said that, with one exception, the ship-building industry was not equipped for this chore and that the only real repository for Naval ship design and specification rested within the Bureau of Ships.

The Navy last week announced that Rear Adm. John J. Fee will succeed Curtze this month as Deputy Chief of BuShips. No replacement has been named for Brockett.

Though it has never been publicly stated, Navy officers say privately that the firm which is generally held as having good in-house design ability in addition to shipbuilding competence is the General Dynamics Corp.

To counter this situation within the industry, Navy officers close to the project expect that the FDL bidding will generate several joint proposals involving teams of ship design firms and construction companies.

Another factor in the admirals' resignation was a complaint concerning the continued establishment of separate project management offices for various programs, a procedure which they believe has also drawn off talent from the Bureau. A project management office for FDL has just been established. It is headed by Rear Adm. Nathan Sonenshein.

• **Trying it out**—In announcing the approval of plans last week to go ahead with FDL development under the new contracting procedures, and in earlier statements, the Dept. of Defense has stressed the fact that the FDL project is "a trial application" of this approach. DOD says it foresees "substantial savings and increased efficiency" in this approach.

Some Navy officers, who are not opposed to the FDL trial say privately that even if the project is successfully applied to development of the relatively

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STAFF Success Improves Hopes for STINGS

THE AIR FORCE is expected to request additional funds to continue hardware development of stellar-inertial guidance systems for ballistic missiles, according to sources close to the project, now that the flight-test phase of development is completed.

The fourth and final flight in the *Stellar Acquisition Feasibility Flight (STAFF)* program was completed successfully at Cape Kennedy on Nov. 12 (see cover).

During this flight, the guidance equipment which was carried aloft aboard a *Polaris A-1* test vehicle sequentially acquired both the North Star (Polaris) and a second star of less magnitude during the boost phase. The flight, made during late afternoon, was the first in which a two-star acquisition was attempted. The second, dim, star to be acquired had been previously selected and programmed into the guidance system.

Ability to move through a two-star sequence is necessary in order to allow guidance systems used in conjunction with any future mobile missile systems to accurately determine coordinates of the initial launch position, predict trajectories, measure deviation, and make corrections.

In the first two flights of the program, the guidance equipment, developed by General Precision Inc.'s Aerospace Group, proved single-star acquisition and lock-on, using Polaris, during nighttime and daylight launchings. The third flight was a failure with respect to the primary guidance experiment, though secondary experiments were carried out successfully.

The secondary objectives of the Nov. 12 flight included further analysis of background illumination problems by injection of particles into the field of view during the boost phase. Other tests included evaluation of gyro drift characteristics in zero-g and further study of the apparent magnitude of both stars used in the experiment. Air Force officers declined to say what the magnitude of the dimmer star was, in order to protect data on system sensitivity.

• **Future possibilities**—Despite the apparent success of the *STAFF* project, the future of the stellar-inertial system is still uncertain. However, the additional funds, if they are forthcoming, will be applied to refining the hardware design of the equipment and reducing it in size.

Observers speculating on the guidance system's future now hang it heavily upon the development of future mobile ICBM's rather than *MMRBM*'s. Another possibility involves an advanced version of *Pershing*—if such a missile system is ever put into development. The Air Force has briefed both the Army and Navy on progress in the *STAFF* program.

simple logistics vessel, they doubt whether the Navy will ever give up its in-house design role for future combat vessels.

However, if the FDL project is a success, and if one result is to build up design competence within the ship construction industry, either through internal expansion or re-alignment within the industry, then it is also held that some re-organization of BuShips, reflecting at least a partial loss of design authority, is inevitable.

- **FDL concept**—The choice of the FDL as the prototype for testing the new development project was dictated because of the vessel's intended simplicity. It is to be, according to DOD, a large, fast vessel, equipped to handle cargo rapidly, with embarked lighters and helicopters for off-loading where there are no port facilities.

The primary mission, according to DOD, is the rapid deployment of ground-force equipment in an emergency operation, rather than the long-distance and time-consuming point-to-point moves which accompany peacetime exercises. In one possible mode of operation, these ships would be loaded with ground force divisional equipment maintained in ready-to-roll condition. With FDL ships strategically deployed, says DOD, airlifted troops could rendezvous with their heavy equipment on short notice. The ships, in effect, would complement use of the C-5A airlift aircraft now in development in the total concept of rapid deployment.

Though the FDL ship may indeed be a simple one, there is nothing simple about the problems that the Navy is already wrestling with concerning the tactics associated with its use.

For example, the Army reportedly has not yet decided what type of equipment to put aboard, nor how much, nor how many divisions should be serviced by these vessels. Storage aboard these vessels at strategic locations could also impose problems of having to buy additional equipment for a division to train with while the division is not deployed. Also, the question of operational control over the vessels and the positioning of them is still believed to be unsettled.

The FDL ships are not expected to carry any armament, which also raises the problem of protecting them by escort. The fact that the ships will no doubt have to be deployed at times in areas where they may be denied dock facilities is also certain to limit the inclusion of so-called roll-on/roll-off capabilities in favor of the boom-loaded lighters and helicopter off-loading.

- **No early RFP's**—Because of the nature of these questions, Navy observers believe it will still be some time before RFP's are actually requested from the industry.

Under the new construction plan, a single contractor will be selected for design, construction, and certain support functions for the FDL. The proposals will be based upon Navy performance and reliability standards. However, there will be no specification by the Navy of detailed ships characteristics or of materials to be used, as in the past. Instead, the Navy says that bidders will be required to include specific guarantees of overall cost and performance.

Only those firms competing for the production contract will be permitted to compete for the initial design contract. The Navy says this will insure that design proposals are technically feasible and that cost figures are responsible. ■

Major MOL Subsystem Contracts Near

Action expected within weeks; Air Force's Satellite Test Center eyed as potential mission control center

CONTRACTS FOR SEVERAL of the major subsystems to go aboard the Air Force's *Manned Orbiting Laboratory (MOL)* are expected to be awarded within the next few weeks, high-level Air Force sources have told MISSILES AND ROCKETS.

This would confirm an earlier report (M/R, Oct. 11, p. 15) which indicated that contracted work on the communications, data management, and attitude-control systems would probably get under way late this month.

Competition for the navigation subsystem for *MOL* was abruptly brought to a halt by Douglas and the Air Force earlier this month for as-yet-unexplained reasons. However, decision on development of this system is now termed as "deferred," possibly for several months, rather than cancelled. It is also believed that responsibility for subcontracting the navigation system has been removed from Douglas.

Douglas has already awarded a definition phase contract for the *MOL* environmental and life support system to the Hamilton-Standard Div. of United Aircraft Co. Allis-Chalmers and General Electric are still competing for a fuel-cell development contract, and both firms have turned in proposals. A decision may also be forthcoming in this area within a few weeks.

In other *MOL*-related activity, sources close to the project say that the Air Force's Satellite Test Center complex in Sunnyvale, Calif., is emerging as the leading candidate with the primary *MOL* mission control center. Expansion of that center to handle the *MOL* role is believed to offer some cost advantages, though AF officers stress that a final decision will be made only when the *MOL* contract definition phase is completed. The AF reportedly does not want to get involved in a control center as costly as NASA's in Houston.

The STC at Sunnyvale is run by the AF's 6594th Aerospace Test Wing; however, the Lockheed Missile & Space Co. in Sunnyvale continues to serve as a technical consultant to the Air Force on Center operations.

- **Pilots picked**—Last Thursday, the Air Force also announced selection of the first eight aerospace research pilots to be assigned to the *MOL* program. Six AF pilots are among the group. They include: Maj. Michael J. Adams, Maj. Albert H. Crews, Capt. Richard E. Lawyer, Capt. Lachlan Macleay, and Capt. James M. Taylor. Two Navy pilots, Lt. John L. Finley and Lt. Richard H. Truly, were also named.

All eight are graduates of the Aerospace Research Pilot School at Edwards AFB, Calif., and all hold degrees in engineering or physical sciences. Two additional increments of six pilots each will be assigned to the *MOL* program in the summer of 1966 and the spring of 1967.

Two of the AF pilots just selected, Captains Crews and Lawyer, were also participants in a two-week military space-station simulation test (M/R, Sept. 7, 1964) made at General Electric's Valley Forge (Pa.) simulator in August, 1964.

Soviet Article Raps DOD Space Role

(The following report by Col. M. Golyshev appeared in a recent issue of the Soviet newspaper Izvestia under the title "Pentagon Grasps for Outer Space." The text is condensed.)

THE CAPITALIST COUNTRIES that possess thermonuclear weapons are striving to conquer space and become the masters in this potential new theater of military activity. The leading role in these endeavors is being played, of course, by the imperialists of the U.S.A.

The United States does not skimp on appropriations for research in the conquest of space for military purposes.

Back at the beginning of this year the President of the U.S.A. sent Congress a report stating that the Defense Department is playing a large part in space research. L. Johnson pointed out that Pentagon outlays for these purposes then amounted to 25% of all the Defense Department's expenditures on weapons research and development.

Just what are the specific military advantages in space that are attracting the Pentagon? Gen. B. A. Shriever, head of the Air Force arms administration, made a concise statement on this subject: "First, the extraordinary altitudes make it possible to observe vast areas of the Earth's surface; second, the speeds are very high."

• **The scope**—The U.S. military space program has already begun to take shape in a whole series of completed, developing and projected systems and projects.

In 1960, the implementation of a 15-year program of developing and orbiting space equipment for military purposes began. It includes nearly 1,000 satellites made according to 12 different designs.

Two years ago two types of *SAMOS* reconnaissance satellites, one light and one heavy, entered the arsenal. Their job is to conduct photographic and radiotechnical reconnaissance. The light ones are launched to take "rough" photographs, to provide small-scale terrain pictures. The heavy satellites (up to two tons) are launched with better-developed photographic equipment, making possible the detection of various objects with linear dimensions of 16 to 20 meters on the territory of a probable enemy (i.e., the Soviet Union and other socialist countries).

SAMOS is also used for radiotechnical reconnaissance: taking fixes on electromagnetic radiation of diverse origin and intercepting information traveling along radio-communications lines.

The Pentagon wants to know where rocket launching sites and strategic airports are situated, where ships and submarines are based and where various objectives of military significance have been built, and also to see what is going out on the airwaves of a number of countries. This is why dozens of *SAMOS* satellites have been sent up into space.

• **SAMOS capability criticized**—These "spies in the sky" by no means always yield the desired effect. There have been many reports in the press on the possibilities for making surveys (only during the day, only in cloudless weather, etc.). In addition, the film supply is so small that the satellite quickly becomes useless.

Another project, in operation since the autumn of 1964, involves the *Transit* navigation satellites. Several such satellites have been put in orbit. They rotate in circular orbits at a height of nearly 960 km. and assist the navigators of ships and submarines.

Just recently the so-called geodesic satellites *ANNA* and *SECOR* underwent testing. They make it possible to take measurements with the help of optical or radiotelemetric instruments. The point of this program is clear and simple: The Pentagon needs a topographical map of strategic targets.

There are many similar projects called upon to satisfy the appetites of the American military.

Lately the Pentagon has also been attaching great significance to manned space ships.

The astronaut, in the opinion of Pentagon leaders, is a light and rather sophisticated discreet computer mechanism possessing comprehensive information pickup units, a memory and a "self-programming" capability. This is why the completed *Mercury* program, the *Gemini* program now under way and the future *Apollo* program include a large number of assignments that have military objectives.

• **GT-5 dissected**—Let us remember certain details of the *Gemini 5* space flight, which took place at the end of August. The flight of Gordon Cooper and Charles Conrad lasted almost eight days.

During these same days, the American press reported that a mission of the flight was to determine the possibility of man's enduring a state of weightlessness for a period of eight days, the approximate time necessary for a trip to the Moon. American information services also did not conceal the other objectives, the purely military ones. It was stated that during the flight Cooper and Conrad would carry out 17 experiments, of which six were purely military and would therefore be kept secret.

During the *Gemini 5* flight a number of three-stage *Minuteman* missiles were launched from the Vandenberg missile base. The astronauts did not observe the first launching, as they were beyond the limits of the field of observation. They photographed the infrared structure. With the aid of the *Gemini 5* radar system, the astronauts established communications with Cape Kennedy. On board the ship there were infrared-ray detectors, which made it possible to carry out "technical experiments" for the Defense Department.

The astronauts carried out visual observation and took photographs of various ground installations, in particular the White Sands rocket proving grounds. *Gemini 5* was used to check out the possibilities of intercepting artificial Earth satellites and carrying on reconnaissance from space.

Representatives of American military circles do not hide the fact that their avowed aim is to achieve strategic supremacy in the sky with the aid of manned space ships.

• **Enter MOL**—One incident is worth noting. On one of the days when *Gemini 5* was still in orbit, President L. Johnson stated at a White House press conference that he had given the Defense Department an order to start work immediately on creating an orbital space laboratory. In the President's words it would provide the data necessary for "America's defense." The launching dates were announced. The first, without a man on board, is planned for the end of 1966 or the beginning of 1967. . . .

What is the laboratory, called the *MOL?* It is a cylinder 12.5 meters long with a diameter of three meters. It is believed that the *Titan III-C* carrier rocket will be able to lift this eight-ton laboratory and two astronauts into orbit.

The Americans intend to attach to the *MOL* station a modified *Gemini* ship, in which the astronauts will remain until they are in orbit. Afterward they will move into the laboratory and carry out the planned experiments, calculated to last two to three weeks. Then the astronauts will return to the *Gemini* cabin, which will get them back to Earth.

According to statements by American military men, such laboratories will be suitable for creating command posts in space, intercepting foreign satellites and making reconnaissance. Such a wide range of combat possibilities gladdens the Pentagon strategists. . . . ■

A Special Report on Space Communications will be published by MISSILES AND ROCKETS on January 31, 1966. This report will give comprehensive coverage of the use of advanced satellite systems for military and commercial telecommunications.

Publication Date: January 31, 1966 **Closing Date: January 17, 1966**
American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Wash., D. C. 20005

Technical Countdown

ASTRONAUTICS

Second LLRV Under Construction

A second Lunar Landing Research Vehicle (LLRV) is being assembled at NASA's Flight Research Center, Edwards AFB, Calif., which is using the machines to validate design features of the Lunar Excursion Module. The operating LLRV now is in a series of flights to determine how low the thrust of the attitude-control system can be cut in operation while retaining control. Pilots report that learning to translate the system under simulated lunar-g requires considerable practice. Due to reduced g-force, much greater tilt angles are necessary to accomplish the maneuver. Both LLRV's are scheduled to be turned over to the Manned Spacecraft Center next fall for astronaut training.

Interplanetary Mission Needs Studied

Requirements for manual control during Mars entry with a high-L/D vehicle at velocities of 40,000-70,000 fps constitutes an important area of study, according to Stanley Deutsch of NASA's office of Advanced Research and Technology. Since *Mariner IV* data indicated a Mars atmosphere density of 10-20 millibars, earlier considerations of parachute landings for large vehicles are not feasible. There also is a continuing need for broad simulation of long-duration (hundreds of days) manned space flights, Deutsch said. A comprehensive mission simulation effort currently is under way at Langley Research Center wherein scientists are planning long-term simulation chamber flights using mission tasks, a semi-regenerating life support-environmental control system, with on- and off-line physiological and behavioral monitoring.

ELECTRONICS

New Particle Acceleration Concept Revealed

Charged particles have been accelerated using a new Russian-developed method to energies equalling "billions of electron volts and within a space limited to a few meters," according to a report by TASS International Service. The developer, Soviet physicist Gurgen Askaryan, has estimated theoretically that a concentration of accelerated particles in a gas medium can boost itself to even greater speeds. It is expected, TASS said, that both high-energy electrons and protons will be obtained with the new approach.

Lightest Sat Com Terminal Developed

A complete transportable ground terminal weighing about 2 tons has been developed by Sylvania Electric for use in military tactical communications via satellite. Believed the smallest self-contained terminal built to date, the van carries its own 12-ft. collapsible paraboloidal-reflector antenna on its roof. Capable of being towed by a small truck or helicopter-lifted, it can be set up and in operation within one hour, developers claim. It has been designed to handle simultaneous two-way voice or teleprinter transmissions.

SPACE MEDICINE

Gamma Radiation Effects Documented

Studies of exposure of rats to gamma irradiation at the St. Louis University School of Medicine indicates that at levels up to 400 rads no significant changes were noted except for the development of a lymphopenia. Above this level, however, changes occurred in all the cellular elements of the blood, increasing in severity according to the increase in radiation dosage. At levels of 1,500 and 2,600 rads, death occurred within the first week after exposure. Dose rate was 125 rads per minute, and levels from 25 rads to 2600 rads were studied, using a cobalt-60 source.

Bioinstrumentation Simplified

Use of an anchor button to solve the problem of dangling bioinstrumentation wires has been found to be effective by the Air Force. The device is a solid plastic button, convex on one side and flat on the other, which fastens on the skin, holding the wires together and out of the way. The flat side has a milled groove designed to hold the lead wires. A commercial sheet with adhesive on both sides is trimmed to form a disc holding the lead wire on in the groove of the button on one side, and fastening the button to the skin on the other.

MATERIALS

X-15 Yields Spacecraft Technology

Efforts to find a suitable heat protection coating for the Mach-8 *X-15*, originally designed only for Mach 6, is resulting in accumulation of the technology required to develop refurbishable ablative coatings for space research vehicles. Engineers at NASA's Flight Research Center, Edwards AFB, say the operational experience being gained in rapid refurbishment, requiring quick spray-on and removal of coatings, will be applicable to any vehicle. This will result in significant savings since recoverable research vehicles need not be fabricated from more expenive materials if properly protected by a coating.

World's Largest Susceptor In Use

A 716-pound tungsten heating element—believed the largest ever—has been fabricated by Union Carbide Corp. for use in Atomic Energy Commission nuclear programs. Developed at the Oak Ridge Y-12 Plant by Union Carbide, operator of the facility, the susceptor is a ring-shaped element measuring 33½ in. in diameter, overall, by 16 in. in height. It already is in use for sintering tungsten components produced by power metallurgy techniques. Products include crucibles, rocket nozzles, nose cones, radiation shields, electron-beam targets and plasma-generator electrodes.

LIFE SUPPORT

Apollo-type Undersuit Viewed by Navy

The water-conditioned suit developed under the direction of Dr. John Billingham of NASA's Manned Spacecraft Center for cooling *Apollo* astronauts also has application of interest to the Navy in supplying heat to immersed personnel, Navy doctors report. Billingham tested the suit under a 3⁄16-in. unicellular foamed diver's wetsuit in 4°C water for over an hour, maintaining his body temperature by using an inlet water temperature of 45°C and a mean flow of 3.8 liters of water per hour. Since the liquid is incompressible and the tubes are relatively rigid, Navy researchers say, the pressure drop in the tubing is not affected by immersion as would occur in a suit dependent upon airflow. A number of heating systems, one chemical, hold promise for use with the suit.

Navy Meeting Need for 2.75-In. Rocket

Old weapon, recalled for duty in Vietnam, is being produced by Naval Propellant Plant; improved techniques are resulting in lower costs, fewer rejects

by John F. Judge

ONE OF THE OLDEST weapons in the U.S. rocket arsenal is now the "bread and butter" round in South Vietnam—the 2.75-in. folding-fin aircraft rocket (FFAR).

Together with the M-6 machine gun, the supression rocket weapon is the primary armament on helicopters operating in Vietnam. The sudden, high-volume commitment of this weapon to Southeast Asia resulted in the swift manufacture of an ordnance item out of production since 1957.

The lead-time problem was compounded because the original manufacturers had long since removed, sold or otherwise disposed of the machine tooling and associated equipment used in the high production of metal parts.

The immediate need for accelerated production rates effectively prevented industry from tackling the project and the U.S. Naval Propellant Plant (NPP) was called on to provide the weapon in the required time.

The 2.75 is propelled by an extruded double-base solid fuel compound and the largest—if not the only—major propellant extrusion production lines in the U.S. are at the Naval Propellant Plant.

In addition, NPP has gathered an impressive staff of technically profficient personnel since 1960, resulting in the assignment of the complete 2.75 propellant grain management function to the plant, plus engineering and procurement responsibility for the rocket motor with its new tube design.

- **Doing it better**—Even though the requirement, tool-up and production of the weapon was accomplished in a few short months in mid-1965, the NPP production management team has turned back almost $7.5 million in initial funding while meeting manufacturing needs.

While full production of the 2.75 ceased in the U.S. in 1957, NPP had been providing re-work propellant grains during the interim period.

Actual production at NPP starts with sheet stock in the shape of "carpet roll" blocks of propellant currently supplied by the Army Ammunition Plant at Radford, Va. (M/R, June 28, p. 29). These rolls are pre-heated and delivered to the propellant extruding lines.

The rolls are extruded and then cut

LEFT: Army Iroquois helicopter crew receives last-minute briefing by radio before taking off in support of ground operations in Vietnam. The 2.75-in. folding-fin aircraft rocket launcher is visible along with other rounds ready for loading in the foreground. CENTER LEFT: An Iroquois launching the 2.75 suppression weapon in training exercises conducted at Fort Rucker, Ala.

to the longitudinal dimension of the 2.75 grain. The grains are then machined to final dimensions after the addition of end inhibitors.

The double-base grains are wrapped with ethyl cellulose tape, which acts as the outside surface inhibitor for the internally burning configuration. These are then shipped to the Naval Ammunition Depot, McAllester, Okla., where the 2.75 is completely assembled.

- **Design refinements**—There have been no major performance design changes in the system since its production phase-out. One reason is the lead-time problem. But there have been innovations in some inert components.

For instance, the motor case was originally manufactured in two pieces, a tube and a screw-on closure. The current motor case is deep drawn in one piece by Norris-Thermador and Alcan Aluminum, eliminating the two-part construction. NPP took the new motor from the design stage directly into production. The Ship Parts Control Center, SPCC, is the processing agency on the conventional hardware for the weapon.

The four nozzle ports in the aft closure are scarfed in the current version of the missile. This introduces a rotation.

The head of the weapon is an ogival steel case threaded internally at the forward end for the fuze and externally at its aft end for motor attachment.

The igniter is positioned on a stabilizing rod immediately behind the head assembly and head closure in the new design. The rest of the weapon is propulsion, except four folding fins in the aft end that deploy in flight.

Overall length is about 48 in. Diameter is 2.75 in., and total weight, with armed and fuzed warhead, is about 18 lbs. The unit was originally designed as an air-to-air weapon, but found application as an air-to-ground missile against a wide variety of tactical targets. The warheads can be attached in the field and there are several types in the inventory.

The production complex now involves Radford, NPP, Canadian Industries, Ltd.—and the Sunflower Array Ammunition Plant, which will soon be brought into the program, with NPP engineers providing technical assistance.

The motor cases are being supplied by Norris Thermador and Alcan Aluminum. Reynolds Metals Co. handles the conventional motor tube segment.

- **Resurrecting materials**—The ethyl cellulose tape used as the grain inhibitor proved to be a major production problem—it had not been manufactured for some 10 years before the new production requirement for the 2.75. NPP is now qualifying vendors for this material.

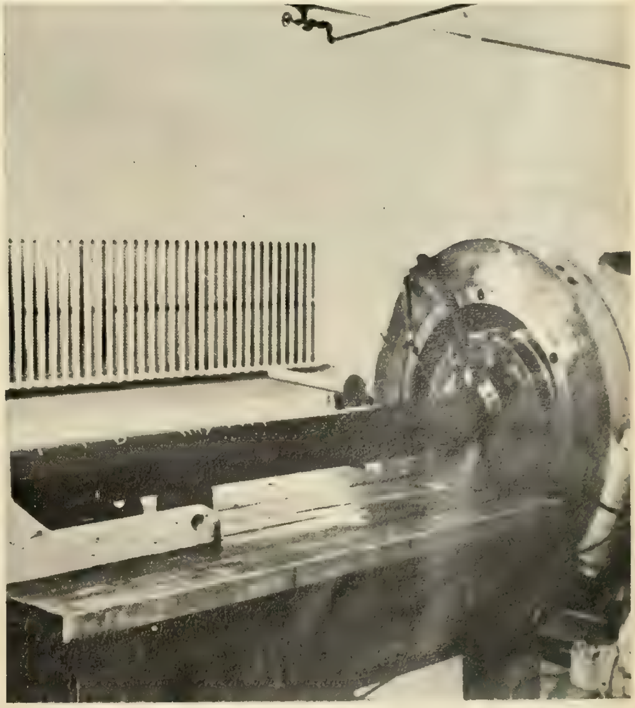
The search for substitute inhibitor materials ran into the lead-time problem again. The cellulose tape problems involved both tolerances and quality. NPP experts say the material is, at the very least, difficult to produce and peculiar in its application.

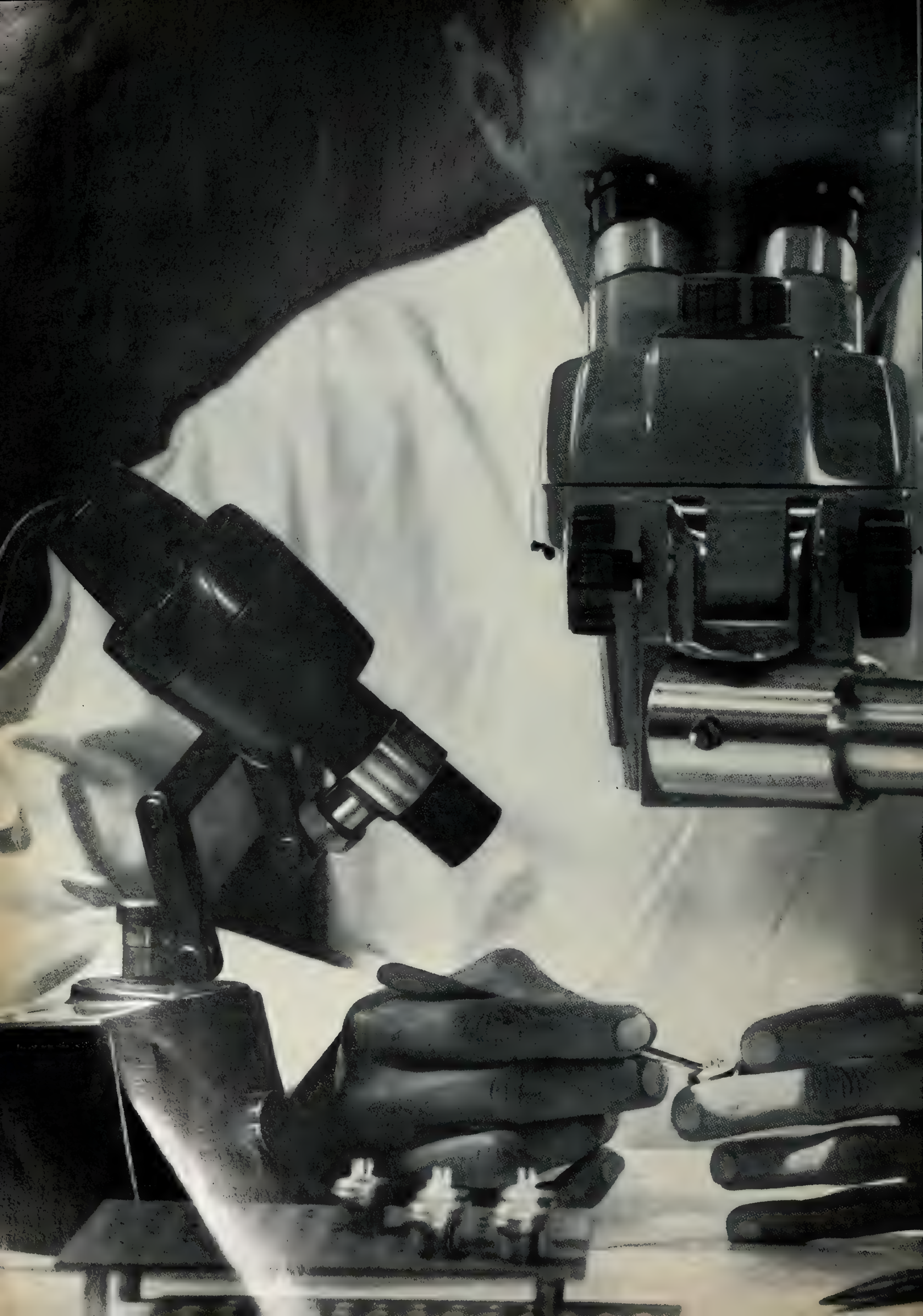
NPP officials say the industry response to the 2.75 acceleration program was good. The pre-production efforts at NPP had a significant effect on both the lead-time period and the reduction in originally proposed costs. In addition, the rejection rate and other quality assurance aspects of the program are running some 80% less than those associated with 1957 production levels. This is because of an increased proficiency in the extrusion of propellants and a greater sophistication in costing such processing efforts now.

Even the costs per unit round in the current production program are less than that for 1957. J. Browning, NPP technical director, says some $4 million alone was saved in the procurement aspects of the 2.75 program. Browning says dealing with NPP seems to sharpen industrial response, since the technical ability at the plant itself is high.

The current production effort on the 2.75 has the Naval Propellant Plant exercising what is normally known as systems management over two Army arsenal plants, a host of industrial contractors in the U.S. and Canada and another Naval installation—providing essential ordnance to a combined combat command without precedent in U.S. military history. ■

CENTER RIGHT: Carpet roll of sheet propellant prior to insertion into extruding press at Naval Propellant Plant, Indian Head, Md. RIGHT: Extruded grain for 2.75-in. rocket motor is very similar to this grain shown emerging from the extrusion press. The internal burning surface is extruded into the grain during the operation.





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ALOTS Advances Airborne Tracking

System built by Nortronics for Air Force is flown on KC-135 and provides superior film coverage; wide potential envisioned

by Rex Pay

ONTARIO, CALIF.—Delivery of the Airborne Lightweight Optical Tracking System (ALOTS) to the Air Force Nov. 12 marked a significant step toward the fuller exploitation of airborne systems for missile and satellite studies.

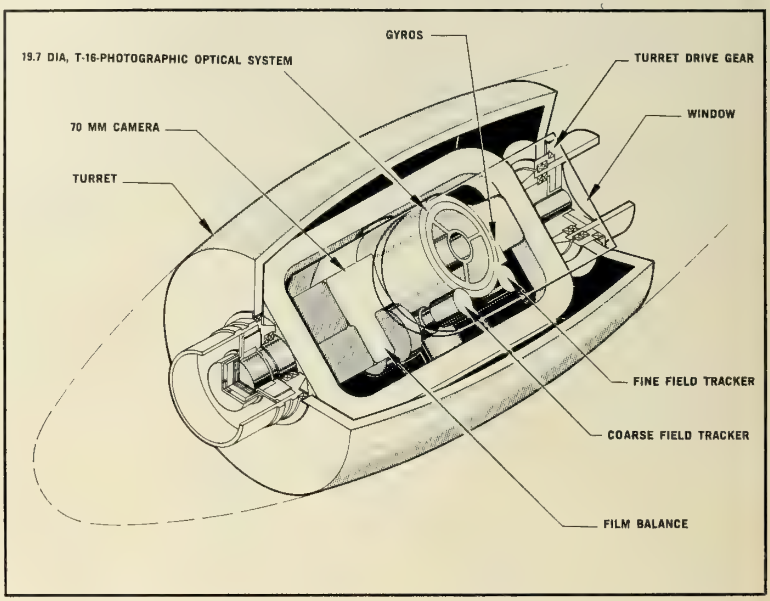
ALOTS, built by Northrop Corp.'s Nortronics Div. under a contract of about $1 million from the Air Force Eastern Test Range, operates on a modified KC-135 jet transport at altitudes of 40,000 ft. to provide high-quality film coverage of missile launch, staging, and re-entry.

Going to an airborne system greatly reduces problems of cloud cover and near-ground turbulence and dust in the atmosphere. Also, mobility, quick response, and low cost are offered in situations where re-entry measurements have to be made on short notice. This requirement might occur in studies of Soviet missile re-entry into the Pacific.

In the ALOTS system, a 200-in. focal length telescope coupled to a television tracking system follows a missile automatically, and is expected to yield a resolution of less than 2 seconds of arc on 70% of the exposed frames, with optimum solar illumination, optimum cruise speed, during straight, smooth and level flight, through maximum coordinated turn, and in light turbulence.

- **Extremely accurate**—This specification corresponds to the ability to photograph a 12-ft. target at 200 miles. One qualification test is to photograph an aircraft at the required resolution at from 5-10 miles range, traveling at a relative speed of Mach 1.6. So far, 4-arc-second resolution has been demonstrated in ground tests in which the system tracked the Moon.

Coupled to the main telescope is a 70-mm camera with a 1,000-ft. film magazine and frame rates up to 80 fps. The system is mounted on the inner gimbal of a stablized platform that is carried in a 2[illegible]-ft.-long pod, 5 ft. in diameter, mounted on the outer surface of the KC-135 cargo door. Total weight of the pod is [illegible],000 lbs. ALOTS inner gimbal payload is 724 lbs.



ALOTS automatic tracking system is mounted in pod attached to KC-135. Manual tracking station is in bubble atop aircraft; control console is inside plane.

Initial acquisition of the target to be photographed is made by an observer using a 14 x 14-degree sight in a bubble on top of the aircraft. At a control console within the aircraft, an operator monitors the appearance of the target in the fields of view of coarse and fine tracking vidicon cameras, adjusting their automatic tracking function to provide an optimum picture in the telescopic camera.

- **Potential as decoy discriminator**—Discussing the potential of airborne tracking systems of this sort, Robert L. Rogers, Nortronics applications engineer on project ALOTS, noted that many other types of payloads could be carried on the inner ALOTS gimbal, and very much larger payload platforms could be produced.

One possibility being informally proposed by Nortronics is an airborne system for discriminating re-entry decoys. For this, a master tracker with a 20-degree field of view would operate in conjunction with a string of remote trackers equipped with spectral discrimination.

The master tracker would acquire the flock of incoming re-entry bodies and feed the coordinates of each into a computer. Logic circuits would assign one object to each of the individual trackers. As each object is tracked, its spectral characteristics are determined and matched with those of its fellows. The one that does not match the others spectrally would have its trajectory computed for insertion into an anti-missile system computer.

All of the techniques required for this system have been demonstrated, said Rodgers, but an integrated system of this sort has yet to be packaged as a single system. Real-time spectral measurements can be made using technology developed for stellar-inertial navigation systems in which stars are recognized by their spectral characteristics.

• Echo results gratifying—A vidicon tracking system flown at 40,000 ft. in a C-135B over the Pacific coast tracked the *Echo* satellite for 17 out of a possible 25 minutes. When the measured orbital elements were compared with those of the Smithsonian Institution, 80% of the data fell within the published 4- to 6-arc minute uncertainty. "It appears that we are able to produce data as good as the best ground measurements," said Rogers. He noted that ground radar failed to track the satellite and ground optics only tracked in daytime when free from cloud cover.

An application of the ALOTS principle of interest to the Air Force Space Systems Div. is satellite inspection (M/R, Nov. 16, 1964, p. 36). This calls for a telescope with about ten times the focal length of the ALOTS instrument. Reduction of telescope tube length could be achieved by a double reflection technique, said Rogers. This produces an all-reflector system whose length is one thirtieth of its focal length, in compairson with the one-fifth of the ALOTS telescope. Rogers said that Nortronics had produced a large-aperture telescope of this new type.

• Aircraft conversion—Conversion of the KC-135 for ALOTS was carried out by Lockheed Aircraft Service Company at Ontario International Airport. The inertial loads induced by the pod, which is mounted on the plane's cargo door, are small compared with the hoop tension and shear loads for which the door was designed, and it continues to perform its original functions. Pod aerodynamic design minimizes the thickness of the boundary layer over the optical window in front of the camera system. The window is optically flat and was ground by Tinsley Laboratories.

The center portion of the pod is a rotating turret that enables the camera system to be pointed at any elevation from directly overhead to directly below the aircraft.

Vidicons, telescope and camera are mounted on a platform attached to the inner gimbal of a two-axis gimbal system housed within the servo-controlled rotating turret. Positioning commands about the aircraft roll axis are applied to the outer gimbal servo of the platform and to the turret servo.

Three servo systems position the platform, one being used for each mode of ALOTS operation: manual track, course track, and fine track. Each servo includes a position sensor, a rate gyro, a d-c torquer motor, and amplifiers.

• How it works—In an operational mission the pilot flies a course that maintains the target at a heading of 270 ± 30 degrees to the aircraft. The manual sight operator centers the target on the cross wires of his sight, activates the camera servos, and continuously tracks the target as long as it is visible. At this time the camera is slaved to the manual sight and the area it is pointing to is indicated by a "flying spot" reticule on the manual tracking station.

When the target enters the 4 x 4-degree field of the coarse tracking vidicon, a light on the control console indicates the presence of a trackable signal and the operator identifies the target on the video monitor. When he pushes a coarse-track switch, control of the camera pointing angle is transferred to an automatic tracking system. The camera is then servoed to the center of the coarse-tracking field.

When the target appears in the 40 x 40-arc minute field of the fine-tracking vidicon, a second signal light goes on and an audio tone appears in the earphones of each operator. The console operator then switches the camera servos to fine tracking and positions a track window on the fine-track monitor screen to provide optimum positioning of the target within the camera field of view. He then starts the photographic camera and continually adjusts its slant range focus on the basis of ground information.

• Optics—The camera optics consist of a 200-in. T/16 system with primary and secondary reflecting elements, a Schmidt-type correcting plate, and an air-space doublet lens and field flattener. The 55-arc minute field of view is sufficient to fill the diagonal of a 70-mm frame.

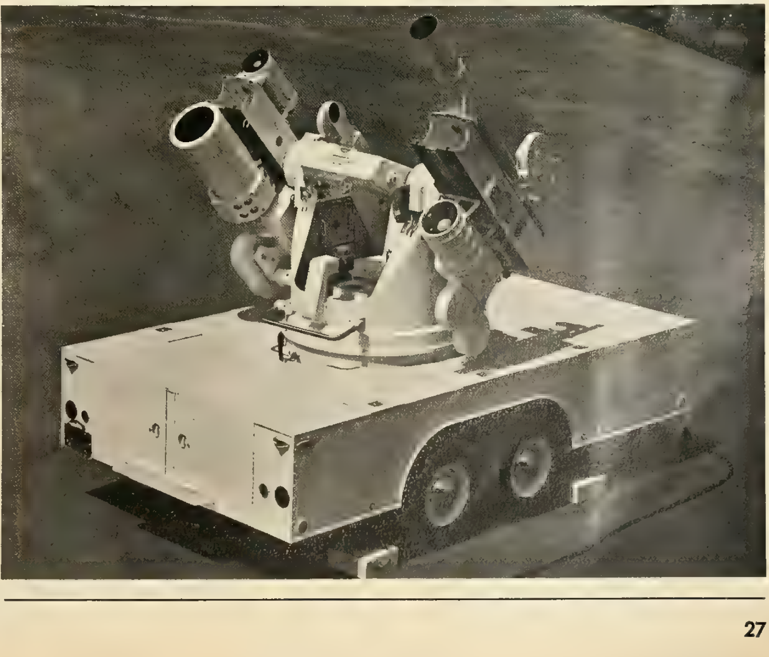
Movable positive registration pins on both sides of the film position successive frames within 0.001 in. of alignment with the fiducial system. Frame rates are accurate to ± 2%. The vacuum back is flat within ± 0.0001 in. over the entire aperture and operates from sea level to 40,000 ft. Four fiducial markers indicate the center line of the frame to within 0.001 in.

When the track window, which corresponds to 20-25% of the raster lines, is placed about the target, noise pulses or other targets outside of the window are excluded from the servo loops. The tracking point is the nose of the target or any other leading edge. As the target pitches over in its apparent trajectory, the console operator rotates the vidicon sensors, preventing the target axis from paralleling the scanning lines.

The vidicon subsystem makes use of two 2000 Series vidicon cameras, camera controls, and two eight-inch monitors produced by Cohu Electronics, Inc. A 729-line system provides the required resolution. RCA 7263A vidicons are used. ■

Navy Gets a Cine-Sextant Missile Tracker

NAVY'S PT. MUGU (Calif.) Missile Center recently received the first of 20 Cine-Sextant missile tracking camera mounts, designed and developed by Photo-Sonics, Inc., of Burbank, Calif., under a $2-million contract. Four movie cameras are mounted on the unit, and others can be placed on bridgeway above operator, who sits within the mount and controls horizontal and vertical movement with a ball-type "joy stick" which is electrically activated.



Sealab III Target Date Is October

Data gained in Sealab II being applied to Man-in-the-Sea planning; RFP's for advanced undersea labs may come by summer

by Heather M. David

PLANNING FOR SEALAB III is beginning at the Navy's Special Projects Office following completion of a successful Sealab II project.

While all the data are not yet reduced (8,000-10,000 cards with 85 bits of data each are still being processed), some of the ideas are already being fed into the Navy's Man-in-the-Sea program.

According to Capt. George F. Bond, SPO Special Assistant for Man-in-the-Sea, the Navy is thinking about a target date of October, 1966, for the next deep-sea demonstration of its M-I-S research program. This Sealab may be placed at a depth of 400 ft. or more, with excursion bounce dives going deeper.

Another major event, which may take place sometime after July, 1966, will be requests for proposals on design of an advanced sea floor habitation and its satellite modules. This complex will represent the final model in the five-year program aimed at extending man's free-ranging capability to live and do useful work on the continental shelves at depths of 600 ft. The modules, Bond told MISSILES AND ROCKETS, will be at various depths, some greater and some shallower for various experimental purposes.

The Sealab II hull will be extensively modified and probably reused, then retired for other use, Bond said. He added that six places are being considered for the next Sealab venture, ranging from Hawaii to the Andros Islands, in both warm and cold, light and dark water areas.

- **Sealab II**—The recent Sealab venture officially came to an end on October 12, when the final 10-man team of the three teams emerged from decompression. A total of 45 days was spent in and out of the 57-ft.-long Sealab chamber at a depth of 205 ft. by the diving teams.

The experiment began August 28, 1965, with the first 10 men, including NASA astronaut Commander M. Scott Carpenter, entering the chamber for some 13 days, checking equipment, exploring the surrounding area, mapping, performing human-factors, physiological and other experiments.

A major problem with which the men had to contend throughout the experiment was the fact that the chamber could not be aligned horizontally and had a list of about 10 degrees. This required that cooking pots and other movable objects be strapped down to keep them from falling, Carpenter said.

The second team, considered the scientific team, went to depth Sept. 13, with Carpenter the only remaining member from the first group. Physiological and marine biological studies were carried on both inside and outside the chamber and results are now being tabulated. Excursions were made as deep as 266 ft. at the brink of Scripps Canyon.

On Sept. 26, third team leader, Master Navy Diver Robert Sheats, and two other team members entered the Sealab, the remaining men the following morning. Salvage procedures were tested, including the use of a special foam to salvage an aircraft hulk and to raise barrels from the bottom, and explosive tools to attach plates and lifting surfaces to a portion of a submarine hull. Other torque-free tools were tested and experiments in sample mining, airlift and bottom coring were carried out.

- **Psychological problems reduced**—Among the immediate findings of the program was the fact that there were no severe psychological problems or slowing down of activity as experienced in Sealab I the previous year. Bond attributed this to better training and definite scheduling of activities and time, leading to less confusion.

Bond pointed out that the confusion that does exist between monitors and test subjects in such situations is always a problem, and that the sooner the "umbilical cord" between the surface and the experiment can be cut, the better. Eventually, the Navy hopes to have underwater roving vehicles capable of autonomous operation for research purposes.

The group had problems with carbon dioxide and carbon monoxide contamination, which is leading to equipment improvements. Problems of skin lesions, earaches and headaches, which bothered some of the men, are now being studied in the laboratory, Bond said, but no answer has been found yet.

- **Space age thinking**—Carpenter, in a special summary report at the National Press Club, pointed out that the science of man in the sea is suffering badly from a lack of the kind of attention that has made the space program so successful. Among the kinds of improvements needed, he listed:

—A diver-to-diver communication system that does not encumber the men with wires or become entangled in breathing apparatus. (Divers now have almost no communications except hand signals and raps on gas tanks.)

—Immediate work on the liquid-cooled *Apollo* suit to adapt it for underwater use and means to maintain thermal balance. Carpenter said that a suit is needed that does not tear easily, but has good thermal balance at depth.

—Better design of the diver's lung. While the astronauts' chestpacks are a model of efficiency, the diver's lung remains an albatross around his neck, Carpenter said.

—Monitoring systems to report on the diver's condition. At present, little of the space-age technology is evident in this field, and the diver remains essentially alone in the water, his condition known only by the bubbles coming from his mask.

—An underwater facility with more room in the diving station, telescopic legs to adjust to uneven terrain, separate laboratory areas, cryogenic gas storage, and departure from the cylindrical design of the Sealab facility.

—Research chambers on the surface with 2,000-ft. depth capability with water-filled and dry compartments capable of pressurization by helium, argon, and other rare gases, in which the effects of pressure and different atmospheres can be studied. Carpenter cited the discrepancy between the space program and the sea program in research facilities of this type. ■

Astronauts Could Land LEM by Earthshine

POSSIBLE EXTENSION of the *Apollo* launch window for lunar landings beyond the presently anticipated 2⅓ days per month has been suggested by the staff at the Manned Spacecraft Center after simulation experiments with helicopters.

Currently, manned landings in the Lunar Excursion Module are planned to take place in sunlight only. The MSC experiments show that there is an extra 3½-day launch window available each month should landings be made using illumination from Earthshine.

The helicopter tests, conducted on the lunar surface-like terrain of the Pisgah Lava Flow on the edge of the Mojave Desert in California, proved that safe landings are possible on such surfaces at brightness levels greater than 0.04 ft.-Lamberts.

This corresponds to the brightness an astronaut will encounter if he lands on a mare with the Earth shining over his shoulders. The Earth would have to be at its full-phase, unless a landing was made on a mare with average to high albedos. On such a mare a landing could be made at three-quarters Earth phase.

- **Adjustments necessary**—The peculiar reflecting characteristics of the lunar surface would mean that the astronaut would have to fly along the "Earthbeams" and would not be able to see areas on either side of him very well.

Also, the LEM thermal design would have to be suitable for night operations on the lunar surface.

However, if there were a need to get to the Moon in a hurry, the Earthshine window would give a launch some 6½ days ahead of the launch window for a sunshine landing.

- **Marines prove feasibility**—Marine Aircraft Group 36 of the Third Marine Aircraft Wing provided two UH34D helicopters and crews for the lunar-landing simulations. The Pisgah Crater lava flow is on the Marine Corps. base reservation at 29 Palms, Calif.

The co-pilot's window, on the left side, was equipped with a LEM window mock-up based on the F configuration of the LEM forward face. The pilot making the descent was fitted with neutral filters to present him with lunar light levels varying from quarter Earthshine and lowest mare albedo to full Earthshine and maximum mare albedo.

Some 50 flights were made over the lava flow, which has low albedo, no vegetation, and very few man-made structures. Trajectories simulated the final 1,000 ft. of LEM landing.

James L. Lewis and Charles D. Wheelwright of MSC report that only seven unsatisfactory landing attempts were made. In these the pilot either tried to land on unacceptable terrain or exceeded a two-minute flight-time limit. All seven failures occurred at light levels of 0.0325 ft.-L or less and represent 21% of the trials at this brightness.

Lewis and Wheelwright concluded that lunar landings attempted at below 0.04 ft.-L would endanger crew safety, while 0.06 ft.-L was found to give safety and an acceptable feeling of confidence. ■

PRIME Lifting Body

MARTIN CO. technicians weigh and balance first boilerplate of PRIME lifting body re-entry vehicle before shipment of the model to Goodyear Aircraft Co. for recovery system tests. Model is one of six that will be pre-flight-tested before launch of four full-scale PRIME vehicles by the Air Force (M/R, Oct. 18, p. 15).

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Apollo Suit Configuration May Be Set in Early '67

HOUSTON—NASA's Manned Spacecraft Center, now acting in the role of prime contractor for the *Apollo* suit program, sees no major problem areas in the suit design and plans to freeze the present configuration—except for minor modifications—early next year.

According to Richard S. Johnston of MSC's crew systems division, the first *Apollo* suits will begin flight-qualification tests next fall for the *Saturn-Apollo 207* mission. The third manned flight in the new series may be launched by mid 1967. Suits for the first two manned *Apollo* mission (*SA-204* and *SA-205*) will be provided by the David Clark Company, Worcester, Mass., under the basic *Gemini* suit contract. (*SA-206* is an unmanned mission.)

In a recent release, NASA announced that International Latex Corp., Dover, Del., will build the *Apollo* suits and Hamilton Standard Div. of United Aircraft Corp., Windsor Locks, Conn., will provide MSC with the portable life support system (PLSS).

Johnston said MSC will enter into an incentive-type contract arrangement with each company. Negotiations, now in process, are expected to be completed early next year. NASA, in its release, said total value of the contracts will be close to $30 million. Nearly $15 million already has been spent by MSC in developing the *Apollo* suit.

The contracts will run through the completion of the *Apollo* program (1970), and will call for ILC to deliver approximately 150 custom-fitted suits, including liquid-cooled underwear, constant wear garments, pressure garment assemblies, and thermo-micrometeoroid overgarments. About 100 of the suits will be "flight suits," Johnston said.

● **'Shotgun wedding' annulled**—When the new arrangement takes effect, total systems management will no longer remain with Hamilton Standard. Instead, responsibility for technical and managerial integration, the role of the prime contractor, will be handled "in-house" by MSC. According to an informed NASA source, this is the result of the "shotgun wedding" of ILC and Hamilton Standard, who were joined in the early contract to develop the *Apollo* suit.

"ILC had the best state-of-the-art suit, and Hamilton Standard, who bid with David Clark Co. as 'sub' had the winning backpack (PLSS) proposal," he explained. Problems began when NASA tried to team the two companies. Working arrangements "deteriorated" between the two contractors and finally ended altogether. Hamilton Standard terminated its contract with ILC and named B. F. Goodrich as the new subcontractor. "The Government really didn't have any real say in the matter." MSC, at this point, insisted on an evaluation of the two suits and then invited a third (David Clark) design to enter the competition "to make sure we got a good suit for *Apollo*."

The three suits competed in 21 individual categories and the results, to be published in an MSC report, "show a pretty good evaluation of present suit technology," Johnston said. Winner and losers alike agreed that the competition was comprehensive and fair, he added.

Among the tests:

—Compatibility studies (with the LEM and Command Module interiors).

—Vision and "reach" ranges within the LEM, CM and on a simulated "lunar surface" at MSC.

—Metabolic expenditures (pressurized, unpressurized).

—X-ray motion picture studies to observe the interrelationship of the suit joints and bone joints.

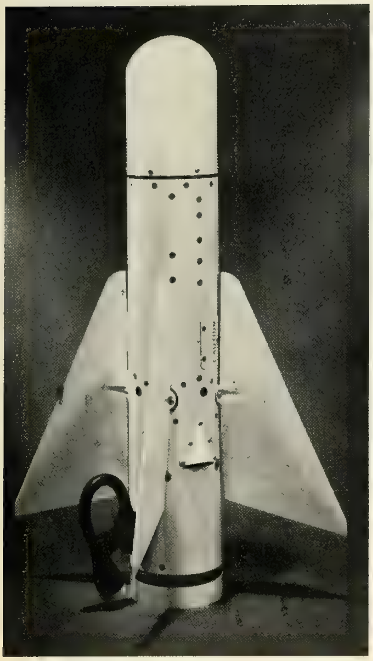
—Suit dimensions (pressurized width measurements) and stowage volumes.

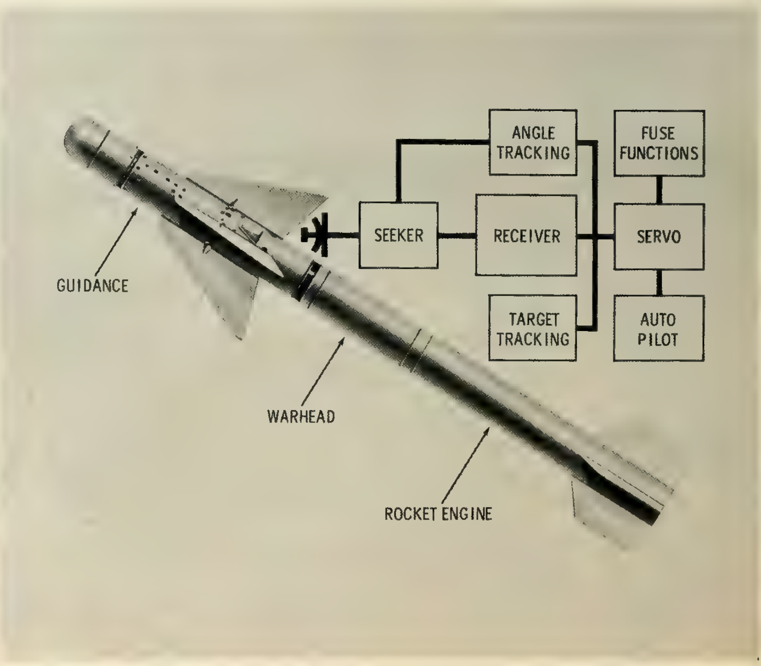
—Maintainability of the suit.

—Comfort (subjective comments from models).

In summing up, the ILC suit came out on top. "None of the suits we evaluated was completely acceptable," Johnston said. The ILC suit showed "excellent mobility," especially in shoulder, hip and knee joints, and "good workmanship." ■

First Photos of New Sidewinder Head





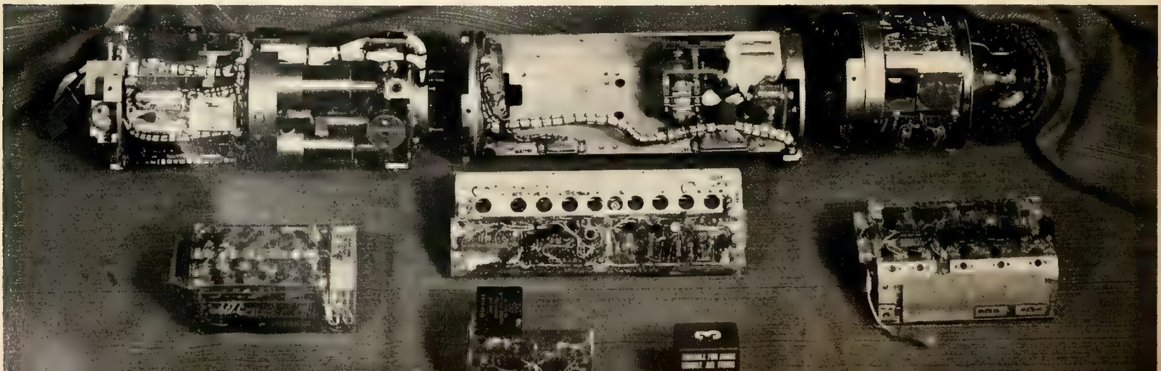
FIRST PHOTOS OF the Navy's semi-active radar-seeker head, now operational on the *Sidewinder 1C* air-to-air missile, show the complete head, the solid-state electronics and nutating paraboloidal-reflector antenna, and a simplified block diagram. The new homing unit is interchangeable with the previously operational passive infrared seeker.

Developed by the Naval Ordnance Test Station, China Lake, Calif., and Motorola's Military Electronics Division, Phoenix, Ariz., the new guidance sections are now in production.

The two seekers give the *Sidewinder* a nearly all-weather capability. Both are expected to be used by the Navy and the Air Force although the Air Force has not yet committed itself on the radar seeker. Effective radar-seeker range is believed to be in excess of 5 n.mi., but can acquire out to 15 n.mi.

The *Sidewinder 1C, AIM-9C* (radar) and *-9D* (IR), is a 185-lb. solid rocket employing four fixed rear fins and four maneuverable forward fins on the seeker section; measures 9½ ft. in length by 5 in. dia., excluding fins; is supersonic and operable to over 50,000 ft. altitude. The weapon carries a high explosive warhead.

The radar subsystem has had a hectic RDT&E period lasting nearly six years. Other than the fact that it exists, no information concerning the unit has been released by the Navy. Even these photos, cleared just recently, were released without captions. ■



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The Industry Week

Mergers and Acquisitions

Systron-Donner Corp., Concord, Calif., plans to acquire Alpha Scientific Laboratories, Berkeley, Calif., at a total price of more than $1.5 million. Purchase will be made by an exchange of stock spread out over a four-year period. Initial payment will be 16,000 shares of common stock. Alpha designs and manufactures analytic instruments for electronic and chemical use. . . . *Bendix Corp., Detroit, has completed acquisition of Besly-Wells Corp., Chicago, in exchange for 99,000 shares of Bendix stock valued at about $5.3 million.* . . . Shareholders of Republic Aviation Corp., currently called RAC Corp., were scheduled to vote on the firm's liquidation on Nov. 19. Plans call for a cash payment of $8-10 per share, payment of half a share of Fairchild Hiller Corp. share for each RAC share held next February, and a "distribution in kind of the capital stock of the company's Swiss subsidiary" (M/R, Aug. 23, p. 41).

New Activities

Fairchild Camera & Instrument Corp.'s Fairchild Semiconductor Div. has established a memory design department. The unit, located in Mountain View, Calif., will design and manufacture memory section components and systems for electronic computers. . . . *Bendix Corp., Ann Arbor, Mich., has formed an Optronics Div. for development and production of optical and electronic equipment and components. The division will be located in Ann Arbor, where new facilities will be constructed early next year.* . . . Sigma-Netics, Inc., has been established in Parsippany, N.J., for manufacture of precision pressure switches for the aerospace industry. . . . *Sperry Rand Corp. has formed a radar sciences group at its Research Center in Sudbury, Mass. The group will offer direct support to government agencies in such areas as radar systems, waveform design and signal processing techniques.* . . . Battelle Memorial Institute's Columbus Laboratories in Columbus, Ohio, has set up a Communication Science Research Center. Work will include study in such areas as mathematical linguistics, neurocybernetics, information storage and retrieval and communication theory. . . . *Ceramagnetics, Inc., has been established in Clifton, N.J., for manufacture of ferrite products for computer applications. The new firm will continue work formerly done by General Precision, Inc.'s Kearfott Div. Three principal officers of the company are former Kearfott employees.*

Facility Expansions

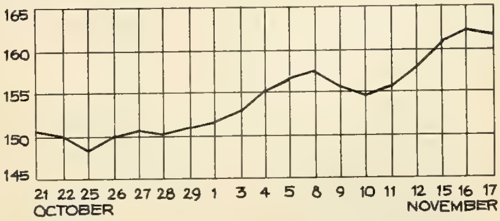
Honeywell, Inc., Minneapolis, Minn., plans to expand its Golden Valley, Minn., plant by 60%. The addition would involve 337,000 sq. ft. of production and warehouse space. Completion is scheduled for July, 1966. . . . *Ampex Corp. plans to double manufacturing capacity of its Magnetic Tape Div. plant in Opelika, Ala. Construction is scheduled to begin early next year.* . . . Raybestos-Manhattan, Inc., Passaic, N.J., has opened an expanded Gulf Coast facility in Houston, Tex. The warehouse/office combines former plants in Houston and New Orleans, La. . . . *Advel Corp.'s Engineered Fasteners Div. has moved into new facilities in Teterboro, N.J. Feature of the new plant is an engineering test laboratory for fastening analysis and recommendations.* . . . Amphenol Corp., Broadview, Ill., has begun constuction of new facilities in Elmira and Toronto, Ontario, Canada, and in Mexico City. Both subsidiaries manufacture electrical and electronic components for aerospace applications. . . . *Pangborn Corp., Hagerstown, Md., is building what is said to be the world's largest abrasive airblast system. The structure will accommodate work pieces up to 30 ft. in diameter and 1,000 tons in weight. The system is being installed in Babcock & Wilcox Co.'s Mount Vernon, Ind., plant.* . . . Avco Corp.'s Electronics Div. in Huntsville, Ala., will move into new, expanded facilities early next year.

International

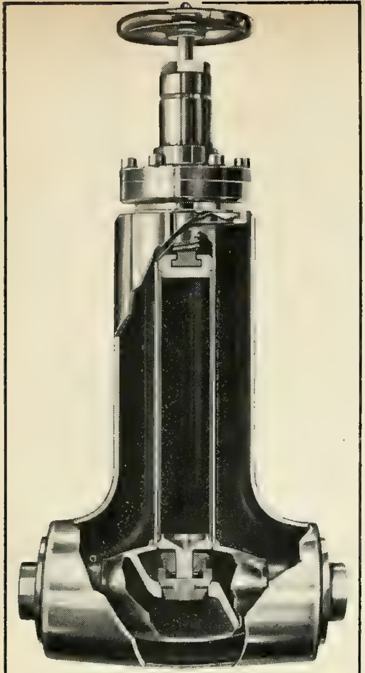
Aviation Div. of S. Smith & Sons (England) Ltd., has purchased interest in the Gap Instrument Corp., Long Island, N.Y. The association of firms has acquired Gorn Electric Co., Stamford, Conn., manufacturer of pressure sensing devices for the aerospace industry. Gap produces analog-digital and solid-state servo systems and computers.

Missile/Space Stock Index

The Missile/Space Stock Index continued its upward climb on the same kinds of events that have brought about its rise in recent weeks. The extremely good third-quarter financial reports by most companies, some large contracts and continued airplane orders, and a great deal of publicity surrounding the effect of the Vietnam situation on the helicopter, plane and arms manufacturers brought the weighted index to above 160 for the first time. (For a complete explanation of the Missile/Space Index, see MISSILES AND ROCKETS, Nov. 15, p. 16.)



100 = CLOSING PRICES OF 19 REPRESENTATIVE AEROSPACE FIRMS DEC. 31, 1964
STOCK PRICES FURNISHED BY MERRILL LYNCH, PIERCE, FENNER AND SMITH



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contracts and procurements

AWARDS

AIR FORCE

$11,000,000—**Marquardt Corp.,** Van Nuys, Calif., from Systems Command's Aeronautical Systems Div. for a low-altitude, short-range missile propulsion technology program.

$5,721,758—**Aircraft Armaments, Inc.,** Cockeysville, Md., for manufacture of electronic countermeasures simulator equipment.

$2,377,835—**Continental Aviation & Engineering Corp.,** Detroit, for continued work on a classified program.

$2,370,000—**Boeing Co.,** Seattle, for modification of early-model *Minuteman* missiles.

$1,975,522—**Collins Radio Co.,** Dallas, first segment of a $3,951,045 contract for manufacture of communication-set components.

$1,720,325—**Stelma, Inc.,** Stanford, Conn., for technical services in connection with communications.

$1,429,336—**Avco Corp.,** Stratford, Conn., for continued work on Mark II-A re-entry vehicles.

$1,349,763—**Boeing Co.,** Seattle, for studies on an advanced, manned strategic aircraft in Renton, Wash.

$1,000,000—**Sylvania Electric Products, Inc.,** Waltham, Mass., funding on a multimillion-dollar prime contract to install an underground cable system for 50 new *Minuteman* missiles.

$880,022—**Avco Corp.,** Research and Advanced Development Div., Wilmington, Mass., for further research and development on the production and utilization of continuous boron filaments.

$792,000—**General Dynamics Corp.,** Rochester, N.Y., for design, development and test of reproduction type "E" Mistram transponder.

$747,544—**Aerojet-General Corp.,** Solid Rocket Plant, Sacramento, Calif., for demonstration of a submerged cooled nozzle.

$722,318—**Control Data Corp.,** La Jolla, Calif., for bioastronautics laboratory research tool.

$117,000—**North American Aviation,** Space and Information Systems Div., Downey, Calif., for continuation of research on stability and transition of laminar boundary layer.

$66,200—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for a program to obtain data on thermal ablation. Also, **Lockheed Propulsion Co.,** Redlands, Calif., $153,400 for preparation and delivery of uncured solid propellants.

$64,392—**University of Kentucky,** Lexington, for research to provide basic information and procedures related to the physiology of space flight.

$61,461—**Atlantic Research Corp.,** Alexandria, Va., for research on deflagration of high-energy oxidizers.

$50,000—**Avco Corp.,** Avco Everett Research Lab., Everett, Mass., for liquid-fueled MHD generator feasibility study. Also, $300,000 to develop and improve a process for producing boron filaments by chemical vapor deposition of boron on tungsten.

$45,789—**Collins Radio Co.,** Dallas, for Loran C timing system.

$40,000—**Southwest Research Institute,** San Antonio, Tex., for continuation of research on response of structural materials to high-intensity pure thermal radiation.

$39,000—**Data Dynamics, Inc.,** Monterey, Calif., for modification of general-purpose tracking network program.

$27,000—**Electronic Communications, Inc.,** St. Petersburg, Fla., for airborne automatic voice communications relay system.

Chicago Aerial Industries, Barrington, Ill., for prototypes of a company developed split-view strike camera. Amount not disclosed.

ARMY

$6,500,000—**TRW, Inc.,** Redondo Beach, Calif., to develop and test modified *Redstone* missiles.

$4,750,000—**Martin Marietta Corp.,** Friendship Airport, Md., for continued production of *Pershing* missiles.

$2,949,000—**Sylvania Electric Products, Inc.,** Waltham, Mass., for research and development work in electronic warfare.

$1,800,000—**Radio Corp. of America,** Missile & Surface Radar Div., Moorestown, N.J., increase in contract for a classified program.

$1,453,471—**Raytheon Co.,** Andover, Mass., in six contract modifications for various parts and services for *Hawk* missile system.

$1,137,908—**Norris Thermador Corp.,** Veron, Calif., to produce 105-mm. projectiles.

$1,000,000—**Varian Associates,** Palo Alto, Calif., for klystron tubes to be used in a missile system.

NAVY

$21,286,000—**Johns Hopkins University,** Applied Physics Lab., Silver Spring, Md., modification for continued R&D on guided missile systems.

$2,395,000—**U.S. Steel Corp.,** McKeesport, Pa., for continued acquisition and installation of production equipment.

$1,416,000—**University of California,** Berkeley, for continuation of research into the basic factors involved in devising and improving methods of defense against potential biological warfare agents.

$1,239,760—**North American Aviation Inc.,** Columbus, Ohio, fixed-price for RA-5C (VIGILANTE) airframe components.

$195,000—**Western Co.,** Research Div., Dallas, for development and fabrication of an aviation fuel-gelling device for Fireye.

$165,489—**Raytheon Co.,** Lexington, Mass., to study measurement of underwater signals at the Atlantic Undersea Test and Evaluation Center.

AEC

$2,400,000—**Martin Co.,** Baltimore, for two pairs of radioisotope-fueled nuclear generators for *Nimbus B* weather satellite program.

NASA

$800,000—**Computer Control Co., Inc.,** Framingham, Mass., from Kennedy Space Center for S-pac digital logic modules and related hardware.

$277,972—**Radio Corp. of America,** Astro-Electronics Div., Princeton, N.J., increase in contract for *Tiros* program.

$163,163—**General Electric Co.,** Oklahoma City, Okla., from Goddard Space Flight Center for multiple system calibration target.

$132,096—**Ampex Corp.,** Cocoa Beach, Fla., from Kennedy Space Center for video magnetic tape recording system.

$93,728—**Fairchild-Hiller Corp.,** Republic Aviation Div., Farmingdale, N.Y., from Western Operation Office for a study to investigate edge bluntness effects.

$57,500—**Ball Bros. Research Corp.,** Boulder, Colo., from Goddard Space Flight Center for *OSO-F* experiment accommodation program.

$49,274—**Hughes Aircraft Co.,** Research and Development Div., Culver City, Calif., from Electronics Research Center, for analytical and theoretical deep-space communication systems trade-off study.

$48,229—**Planning Research Corp.,** Los Angeles, from Goddard Space Flight Center for reliability study of the radio astronomy *Explorer.*

Quantic Industries, Inc., San Carlos, Calif., from Ames Research Center, for the design and test of an earth aspect sensor. Amount not disclosed.

Radio Corp. of America, Communications Systems Div., Camden, N.J., from Manned Spacecraft Center to develop a miniature TV tape recorder for spacecraft that will be capable of storing over 50,000 TV pictures and have the ability to record for either normal or slow scan systems. Amount not disclosed.

Circle No. 6 on Subscriber Service Card

INDUSTRY

$4,268,885—**Electronic Communications, Inc.,** St. Petersburg, Fla., from **Radio Corp. of America,** New York, N.Y., for tactical multiplex set and support equipment.

$900,000—**Energy Systems, Inc.,** Palo Alto, Calif., from **Sylvania Electric Products, Inc.,** New York, N.Y., for design and manufacture of a high-power radar transmitter to be used with a long-range tracking and instrumentation radar system that will aid anti-missile studies.

$497,000—**Varian Associates,** Palo Alto, Calif., from **Raytheon Co.,** Lexington, Mass., for tube development work.

$177,596—**Dorsett Electronics, Inc.,** Tulsa, Okla., from **Ryan Aeronautical Co.,** San Diego, Calif., an add-on for telemetry systems for the Ryan *Firebee* target drone.

CORRECTION

The $1,009,000 Navy contract for shipboard equipment listed Nov. 8 was awarded to the **Dynamics Corp. of America,** Long Island City, N.Y., and not to **Dynamics Corp.,** Stoneham, Mass.

REQUESTS FOR BIDS

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Endeavoring to negotiate a contract with Aerochem Research Laboratories, Inc., Princeton, N.J., for a study of atomized liquid jet effects on re-entry plasma sheaths. For information only; RFP not available.

Contracting Officer
National Aeronautics and Space Administration
Langley Station
Hampton, Va.

Endeavoring to negotiate a contract with Littleton Research and Engineering Corporation, Littleton, Mass., for a research program to investigate the application of piezo-electric actuation of a fatigue-testing machine. For information only; RFP not available.

Picatinny Arsenal
Dover, N.J.

Proposed to procure services and supplies for cost-reduction study of fuze GM XM813 for the *Shillelagh* guided missile by a modification of existing contract DA-28-017-AMC-2390 (A) with Bulova Watch, Flushing, N.Y. This will be a single-source procurement. For information only; RFP not available.

National Aeronautics & Space Admin.
Western Operations Office
150 Pico Blvd.
Santa Monica, Calif. 90406

Negotiating a contract with Astro Research Corp., Santa Barbara, Calif., for structural design development for large orbiting radio astronomy antennas. For information only; RFP not available.

Air Force Flight Test Center
Directorate of Procurement (FTMKR-4)
Edwards Air Force Base, Calif. 93523

Negotiations are being conducted with Astrodata, Inc., 240 East Palais Road, Anaheim, Calif. 92700, to develop seven additional timing terminal subsystems. This procurement is follow-on effort conducted by the contractor under contract AF 04(611)-9963 PR. No. 52637009.

Directorate of R&D Procurement
System Eng Group
RTD
Wright-Patterson Air Force Base, Ohio 45433

Negotiations will be conducted with Lockheed Aircraft Corp., Lockheed Missiles and Space Co., Sunnyvale, Calif., for instrumentation for orbital evaluation of solar reflector candidate materials. For information only; RFP not available.

Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135

Negotiations will be conducted with Hughes Research Laboratories, a division of Hughes Aircraft Co., 3011 Malibu Canyon Road, Malibu, Calif., for additional testing of a 4-strip ion engine. For information only; RFP not available.

Procurement Division
Building 4603
Aberdeen Proving Ground, Md.

Negotiations being conducted with Firestone Tire and Rubber Co. for research work in the field of spin-compensated shaped charges. For information only; RFP not available.

National Aeronautics and Space Administration
Goddard Space Flight Center
Glenn Dale Road
Greenbelt, Md.

A contract to develop two blackbody temperature sensors to be negotiated with the G. T. Schjeldahl Co., Northfield, Minn. For subcontracting possibilities only; RFP not available.

Bureau of Naval Weapons
Washington, D.C. 20360

Conduct a research program to determine the development feasibility of the dual-area nozzle and its applicability to several current advanced Navy solid-propellant missile systems. Intends to solicit a quotation from Rocketdyne, Solid Rocket Div., McGregor, Tex. For information only; RFP not available.

Procurement and Production Office (SSOK)
AF Satellite Control Facility
Los Angeles AFS, Calif.

Negotiations will be conducted with Philco Corp. Western Development Lab., Palo Alto, Calif., for special support activities for satellite control facility. For information only; RFP not available.

NASA Headquarters
Washington, D.C.

Investigation of performance of Langmuir probes in the ionosphere. NASA is negotiating with GCA Corp., GCA Technology Div., Bedford, Mass. For information only; RFP not available.

Fort Monmouth Procurement Division
Procurement and Production Directorate
U.S. Army Electronics Command
Fort Monmouth, N.J. 07703

An award is being made to Hughes Aircraft Co., Grounds Systems Group, 1901 West Malvern Ave., Fullerton, Calif., to continue research work in the field of satellite communications. For information only; RFP not available.

U.S. Naval Ordnance Test Station
3202 E. Foothill Blvd.
Pasadena, Calif. 91107

Evaluation study of advanced warheads for *Asroc* missile negotiations are to be conducted with Honeywell, Inc., West Covina, Calif. For information only; RFP not available.

NASA Headquarters
Washington, D.C.

Research leading to development of an atomic hydrogen maser for space-vehicle application. NASA is negotiating with Varian Associates of Beverly, Mass. For information only; RFP not available.

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ELECTRICAL DESIGN ENGINEER SENIOR

Design experience including schematic diagram presentation, electrical/electronic components, design installation and related circuit design and analysis for automatic checkout equipment.

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ELECTRICAL DESIGN ENGINEER—JUNIOR

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Not to mention several other variables that probably have never darkened the door of a land-based missile or space systems engineer.

When you're accustomed to lots of real estate around the pad, plenty of power, roomy computer rooms and command control centers as big as a small town... some of the technology that has brought three generations of Polaris to reality might sound a little unreal to you.

And there's more involved than packaging it all in a submarine.

The control systems we're working on today must be more than microminiaturized and ruggedized to withstand operational extremes (which include attacks on the submarine itself.) They must be more automated, more self-checking, more sophisticated (flexible targeting) to feed the proper guidance instructions to 16 missiles regardless of the submarine's location at the moment of launch, its depth, pitch, yaw, surface conditions, weather, etc., etc., etc.

Ordnance Department
GENERAL ELECTRIC
Pittsfield, Mass.

New Product of the Week: Portable Engine-Generator

A self-contained power generating system, especially suited to applications where close power and frequency tolerances are required, has been developed by Westinghouse Electric Corp.'s Aerospace Electrical Div.

The 60-kw, 400-cps unit is said to be the first practical use of a rotary combustion engine in the U.S. The engine is combined with a brushless generator and solid-state regulation and control circuits.

Compared to a gas-turbine generator, the rotary combustion system has approximately the same weight (1,080 lbs.) and a fuel consumption of 9.5 gallons/hour, compared to 17 gallons/hour for the gas turbine, the firm says. A comparable diesel-generator would have a weight of 4,700 lbs. and a fuel consumption of 6 gallons/hour.

Operating values of the new system include: voltage regulation, ±2%; voltage transients, ±15%; frequency regulation, ±0.25%; frequency transients, ±3% (full load); and frequency modulation, ±0.25%. Overloads are 125% at 0.8 power factor for 5 min. and 200% at 0.4 power factor for 5 secs. Temperature range is −65° to 125° F.

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Torquer-Potentiometer

Vernitron Corp. is marketing an integral d-c torquer-potentiometer, designed to provide up to 20 oz.-in. positioning torque plus position feedback signal.

The Model VS-76 is constructed to eliminate mechanical linkages between the driving member and the feedback member. It measures 1.937 in. in diameter and 0.900 in. long (less shaft). Voltage at peak torque is 31v dc; potentiometer resistance is 3,500 ohms. Rotor moment of inertia is 1.0 x 10^{-3} oz.-in. sec.^{2}

Circle No. 152 on Subscriber Service Card

Count down

We've been writing books about the "etceteras." Some of them on projects too new to mention. Now is the time to join us. In these areas:

System Engineer
Establish Weapon Control System requirements, conceive new digital and hybrid digital/analog system designs, conduct trade-off studies, and identify and solve interface problems with other systems. Plan and conduct engineering hardware evaluation of this system.

Electronic Circuit Engineer
Develop, design, package and evaluate digital and analog electronic circuits to meet requirements of Weapon Control systems and subsystems. Analyze, design and evaluate circuits and packaging techniques—using both discrete solid-state components and integrated microelectronic circuits for applications such as submarine fire control, gun mount and antenna drives, digital servos, sophisticated space power conversion and control equipments.

Engineer—General Purpose Computer
Responsible for technical leadership of engineering group, who will conceive, develop, and evaluate unique designs of General Purpose Computers for Weapon Control Systems. Technical liaison with government agencies, customers and vendors. Direct knowledge of logical design techniques, General Purpose Computer organization and programming. Knowledge of numerical techniques and analytical methods desired.

Logic Design Engineer
Technical direction of engineering group designing the digital portion of a developmental control system. Will monitor the state of the art in digital memory design, software techniques, and microminiature modules and apply these to logic design and mechanization of control systems. Position requires experience in solid state circuit design and knowledge of computer programming techniques and compiler organization.

Digital Systems Design Engineer
Responsible for concept and development of digital computational and control systems for inertial guidance and fire control test equipment. Establish system design requirements utilizing knowledge of the state of the art in digital data handling and mechanization techniques. Perform trade-off analysis to determine optimum mechanization approach. Position requires knowledge of techniques for tolerance partioning and real-time input/output equipment.

Program Engineer
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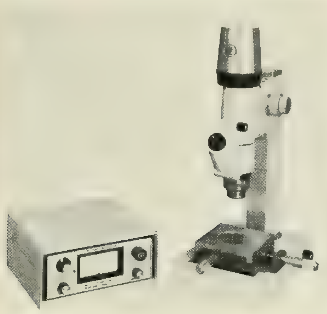
Infrared Microscope

The Model RM-2A infrared microscope, designed specifically for determining temperature distribution of microcircuits, has been announced by Barnes Engineering Co.

The device detects over-stressed and non-uniform components and thus can be used to determine circuit reliability in both design and production phases, the firm says. It uses a liquid-nitrogen-cooled indium-antimonide detector mounted in a stainless steel dewar. The dewar holds a 12-hr. supply of nitrogen and is designed to permit operation in both horizontal and vertical positions.



Interchangeable objectives are available in sizes of 15x, 36x and 74x, providing spot sizes of 0.0014, 0.0007 and 0.0003 in. in diameter. Accessories include a specimen heater, a radiometric calibration unit and specimen illuminators.

Circle No. 153 on Subscriber Service Card

SWR Meter

A standing wave ratio meter with a noise-figure specification of less than 4 db has been developed by Hewlett Packard Co.

The Model 415E can also be used to measure attenuation, gain and other parameters determined by the difference between two signal levels. An expand-offset feature allows any 2-db portion of the instrument's 70-db range to be expanded to full-scale for maximum resolution at a specified linearity of ±0.02 db.

The unit operates with crystal or bolometer detectors with capability to operate from both low (100-ohm) and high (5,000-ohm) source impedance crystals. Bial currents of 4.5 or 8.7 ma can be selected on the front panel.

Circle No. 154 on Subscriber Service Card

Solid-State Log Amplifier

A solid-state logarithmic electrometer amplifier, designed to measure currents in the range 10^{-11} to 10^{-5} amps in 20 ms or less, has been developed by Adcole Corp.

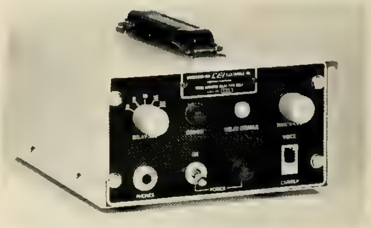
The Model 330 is used on space vehicles in conjunction with instrumentation such as retarding potential analyzer particle detectors. Field effect transistors are used for input stages in place of electrometer tubes, freeing the amplifier from microphonics and zero offset due to filament voltage variation, mechanical shock and light. Drifts, referred to the input gate, are less than 10 mv over a temperature range of −10° to 60° C.

The instrument can be adapted to meet specific needs. Variations include units with circuitry for displacement current calcellation, floating amplifiers for variable input d-c levels and any fixed d-c input level between ±100v.

Circle No. 155 on Subscriber Service Card

Signal-Operated Relay

Communication Electronics, Inc., has developed an ultra-sensitive signal-operated relay amplifier device, the Type SOR-1.



The unit can be actuated in 0.1 sec. by voice or carrier to control a tape recorder, transmitter or alarm system. Sensitivity is variable by a threshold control; in carrier mode, it ranges from 0.1 to 2.0v dc. In voice mode, its range is 0.1 to 2.5v RMS with a voice bandwidth of 165 cps to 10 kc at 3 db points referenced to 300 cps. A delay selector switch sets the relay to remain closed 0.0, 0.5, 5, 10, 15 or 20 secs. after an actuating signal has been removed.

The unit weighs 4.5 lbs. and measures 6 in. wide and 3.5 in. high. Input is 115v ac, 50 to 400 cps, 7 watts.

Circle No. 156 on Subscriber Service Card

Resistance Comparison Unit

Rosemount Engineering Co. is marketing a resistance comparison bridge, the Model VLF 51.

The unit uses current transformers operated at 1 kc to determine the ratio of two resistances. A modulation/demodulation technique enables resistance comparison to be made at 5 cps, thus taking advantage of the accuracy of permeable toroidally wound transformers and eliminating the reactive effects of ac, the firm says. Digital readout is accurate to within 20 ppm from 0.1 to 500 ohms.

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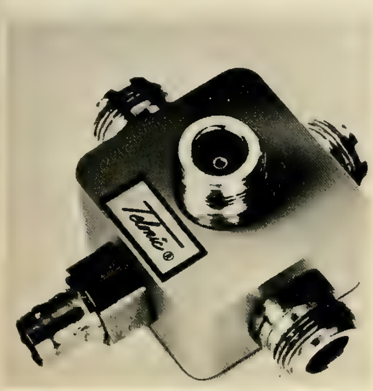
Impedance Comparator

Telonic Engineering Co. is marketing a precision impedance comparator for VSWR measurements up to a level of 6:1 over a frequency range of 1 MHz to 1 GHz.

The Model TRB-4 is used with an oscilloscope or X-Y recorder and incorporates a frequency-insensitive RF bridge-detector circuit. It has an unbalance, or return loss, of 50 db minimum, corresponding to an accuracy of 0.633%.



The device is available as a single unit or part of a VSWR test kit which includes matched and mismatched RF terminations.

Circle No. 159 on Subscriber Service Card

Ionization Chamber

A free-air ionization chamber which gives absolute dose measurements of X and gamma radiations within an energy range of 5 to 50 kev has been developed by the Victoreen Instrument Co.

The unit utilizes a double-telescoping cylinder design which, developers say, makes it unaffected by inaccuracies normally affliciting such equipment since errors tend to cancel each other out. The model eliminates electrostatic field non-conformity, peculiar to parallel plate chambers, caused by limitation in precisely defining a known volume of air. Energy response is nearly flat between 100 and 1,250 kev.

Circle No. 160 on Subscriber Service Card

Aerospace Materials

A variety of porous metal and ceramic structure for use in aerospace defense and commercial applications has been announced by Astro Met Associates, Inc.

Pore sizes from less than 1 micron to more than 2,000 microns are available in volumes from 10% to 97%. Structures are limited to those metals and ceramics which can be sintered by heat in various atmospheres. Materials produced as porous structures have been refractory metals and ceramics and other materials such as lead, copper, bronze, Monel 316 stainless steel, iron, nickel, fused silica, spodumene and titanates.

Inventoried porous materials are simple block shapes up to 1 x 5 x 5 in. in most popular materials, such as nickel, tungsten, alumnia and zirconia.

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Deluge Valve

Fike Metal Products is marketing a deluge valve designed to react instantly to quench a reaction or activate a reaction.

The unit is available in various sizes for such applications as in solid fuel rocket testing, fire control and shock tube applications. The valve incorporates an explosive charge that can be detonated manually or by a predetermined temperature or pressure set point. Inert poison in liquid, gaseous or solid state may be used as media to kill, slow down or control reactions.

In tests, the device operated at up to 100% of rupture pressure and quenched the flame of a solid fuel rocket in 5 millisecs.

Circle No. 162 on Subscriber Service Card

Frequency Doublers

A series of microwave frequency doublers with efficiences of 70% at C- and X-band outputs and 60% at Ku-band has been announced by L. P. Associates, Inc.

Output power levels at X-band (8 MHz) are greater than 500 mw. At Ku-band (16 MHz), output powers are on the order of 250 mw. Harmonically related spurious outputs are down about 25 db. Greater attenuation (up to 100 db) can be obtained with post filtering.

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Experimental Diode

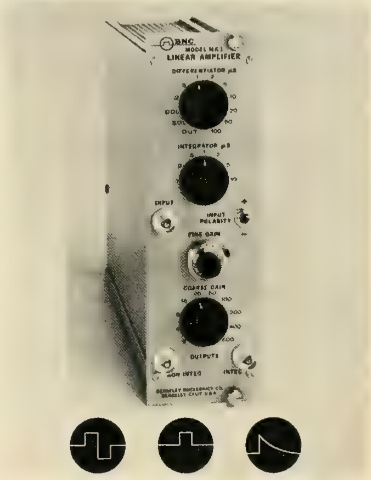
IBM Corp. has developed an experimental diode, which is light-emitting and exhibits strong negative resistance, for experimentation by other laboratories.

The gallium arsenide diode is composed of three layers—a central high-resistivity p-type layer flanked by low-resistivity n- and p-type layers. Infrared light at 9,000 Angstroms is emitted from the high-resistivity p region when the diode is in the low-resistance state. The efficiency of light emission is comparable to that of ordinary gallium arsenide diodes. It can sustain up to 100 milliamperes continuously at room temperature in the "on" state.

Circle No. 164 on Subscriber Service Card

Linear Amplifier

A multiple-function linear amplifier, which provides single delay line, double delay line and RC clipping of pulses, has been announced by Berkeley Nucleonics.



The Model MA-1 provides two simultaneous outputs — an integrated pulse for pulse height analysis and a non-integrated pulse for crossover timing applications.

Specifications include an output rise time adjustable from 0.1 to 10 µ secs.; clipping time from 0.2 to 100 µ sec.; output amplitude of ±10v; differential linearity of better than ±1% and x 100 overload recovers in less than 4 µ sec.

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Tone Burst Generator

A tone burst generator which provides simultaneous outputs of plus and minus gates, double pulse and linear ramp functions as well as coherent tone bursts has been announced by Edison Instruments, Inc.

The unit feaures a one [illegible] burst with a duration of 50 microsecs. to 5 secs. Specifications include a frequency range of 20 cps to 500 kc, gate open range and gate closed range of 50 microsecs to 5 secs. Square wave pulses have a 10-v peak for both plus and minus gates. Pulse repetition rate is 12 per minute to 20 kc and continuously variable in three ranges.

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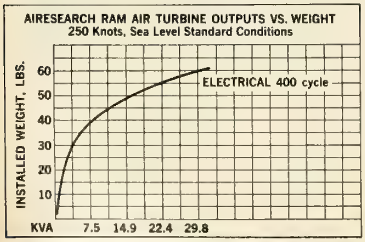

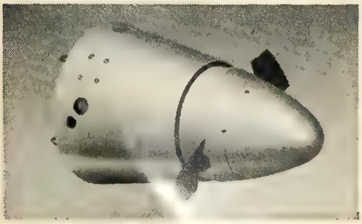

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names in the news

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James A. Reeves: Elected president of Spacelabs, Inc., Van Nuys-based bioinstrumentation company, succeeding **Ben L. Ettelson,** who becomes chairman of the board.

William O. Fisher: Elected president of the Strategic Industries Assn. He is financial vice president and a director of Swedlow, Inc.

Dr. Oliver Ray Price: Elected to the office of vice president of Datapulse Inc. He is also currently serving as general manager of the company's KRS Instruments Division.

John Meier: Elected president and a director of the Aerospace Controls Corp. He will be responsible for directing the engineering activities of the five new divisions of the company.

W. R. McQuiston: Appointed vice president and electronic systems operations manager of Electronic Engineering Co. He will be responsible for manufacturing, purchasing, quality control, and four of the company's major product engineering groups.

T. M. Butler: Elected vice president-engineering of Burroughs Corp. He was in charge of the engineering group which developed the Sensimatic accounting machine.

Carl H. Mueller: Appointed vice president of research, development and engineering for Lincoln St. Louis, a division of McNeil Corp. He joined the company in 1930.

Robert L. Abbott: Named to the position of director, military and aerospace marketing for FMA, Inc. He will direct the company's marketing activities, located in Los Angeles, Dayton, Ohio, and Washington, D.C.

Gene K. Beare: Elected president of the National Electrical Manufacturers Association. He is president of Sylvania Electric Products, Inc. **John Morrill** was elected a NEMA vice president to succeed Mr. Beare.

Kenneth P. Randall, joined the DeMornay-Bonardi and KRS Instruments Div. of Datapulse as senior mechanical engineer. Previously, he was with Micro-Radionics, Inc., as head of the mechanical engineering and drafting sections.

Russell Corlett: Named chief engineer of May-Fran Manufacturing Div. of Fischer Industries. He has been associated with the company for 15 years.

Dan Connolly: Named applications engineer of Memorex Corp. He will serve customers out of the Washington, D.C., office.

Dr. Anthony G. Oettinger: Appointed to the Research Advisory Committee of System Development Corporation (SDC). He is the Gordon McKay professor of applied mathematics and a professor of linguistics at Harvard University.

Deloy G. Monroe: Elected vice president and director of engineering for Sparton Corp. He has been director of engineering for the Sparton Electronics Div. in Jackson, Mich.

Dr. John N. Dempsey: Elected a corporate vice president of Honeywell, Inc. He is director of research at the company. He has directed the center's staff of 200 scientists, engineers, technicians and support personnel since 1961.

William Sichak: Named vice president and technical director at Communication Systems, Inc., following the recent acquisition of Sichak Associated by CSI.

William S. Ivans: Elected vice president of Cohu Electronics, Inc., succeeding La Motte T. Cohu. **Robert E. McDowall** was named executive vice president.

Robert G. Genzlinger: Appointed manager of manufacturing for Ex-Cell-O Corp.'s, Bryant Computer Products facility. He will be responsible for the division's Walled Lake, Mich, and Springfield, Vt., manufacturing operations.

Cameron B. Forrest: Joined Tasker Instruments Corp. as executive engineer. He will be responsible for the direction and formulation of plans for the engineering department.

Charles G. Chisholm III: Named Atlantic coast regional sales manager for Wrought Products of Union Carbide Corp., Stellite Div. Mr. Chisholm served for nearly six years as a Navy pilot.

Dr. Martin L. Klein: Joined Electro-Optical Systems, Inc., as a specialist in the planning and development of programs related to communications and data systems.

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missiles and rockets
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International Symposium on Electromagnetic Sensing of the Earth from Satellites sponsored by the University of Miami, American Meteorological Society, American Geophysical Union, Optic Society of America, University of Miami, Coral Gables, Fla., Nov. 22-24.

Symposium on Interactions of Space Vehicles with an Ionized Atmosphere, sponsored by the American Astronautical Society, University of Miami, International Radio Union, Deauville Hotel, Miami Beach, Fla., Nov. 26-27.

1965 Fall Computer Conference, Convention Center, Las Vegas, Nev., Nov. 30-Dec. 2.

1965 Ultrasonics Symposium, sponsored by the Group on Sonics and Ultrasonics of the Institute of Electrical and Electronics Engineers, Hotel Sheraton-Boston, Boston, Dec. 1-3.

Vehicular Communications Conference, sponsored by the Institute of Electrical & Electronics Engineers, Sheraton-Park Hotel, Washington, D.C., Dec. 2-3.

American Chemical Society Southeast-Southwest Regional Meeting, sponsored by the American Chemical Society, Peabody Hotel, Memphis, Tenn., Dec. 2-4.

Sixth Annual Symposium on Filament Structures Technology, sponsored by the American Society of Mechanical Engineers, New Mexico Section and the University of New Mexico, University of New Mexico student union building, Albuquerque, N.M., Dec. 3-4.

American Institute of Chemical Engineers 58th Annual Meeting, sponsored by the American Institute of Chemical Engineers, Bellevue Stratford Hotel, Philadelphia, Dec. 5-9.

Integrated Circuits Applications & Economics Seminar, sponsored by Integrated Circuit Engineering Corp., Marriott Motor Hotel, Philadelphia, Dec. 6-10.

Eighth Annual Army Aviation Contract Services Symposium, sponsored by the National AeroSpace Services Association, Washington, D.C., Dec. 6.

NSIA/AFSC Microelectronics Conference on "Applications of Microelectronics Technology," sponsored by the National Security Industrial Association and the Air Force Systems Command, Sheraton-Park Hotel, Washington, D.C., Dec. 8-9.

American Association for the Advancement of Science 132nd Annual Meeting, sponsored by the American Association for the Advancement of Science, University of Calif., Berkeley, Calif., Dec. 26-31.

National Defense Transportation Association's Regional Defense Transportation Conference, sponsored by the National Defense Transportation Association, New York Hilton Hotel, New York, Dec. 9.

First Annual Conference on Operating Metallurgy, sponsored by the Metallurgical Society, Penn-Sheraton, Civic Arena, & Exhibit Hall, Pittsburgh, Nov. 29-Dec. 3.

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Truth and the MOL

WITH THE *Manned Orbiting Laboratory (MOL)* project in its formative stages, it is now time for the Dept. of Defense to establish a sensible public information program for *MOL* which will protect adequately both any classified information involved and the public's right to know what its Government is doing.

It is time to throw out some of the stupid, head-in-the-sand, misleading and misguided policies that today make up much of what passes for public relations at the Pentagon.

It is time to determine what portions of the *MOL* program should fall under military security and what portions into the province of military and industry public relations. There should be a minimum of the former and it should be restricted almost entirely to specific items of equipment.

It is time for the Administration to acknowledge the inane and embarrassing mistake made when it adopted the Soviet Union's old habit of rewriting history in an effort to pretend the *SAMOS* and *MIDAS* reconnaissance satellite programs did not and do not exist. To allow the State Dept. to determine military security policies for DOD programs is to follow the path of folly.

Even worse than the decision to put these programs behind a security curtain was the hare-brained attempt to do it in mid-project. Newsmen, this editor among them, were invited to and witnessed the first *SAMOS* launch from Vandenberg AFB in California. The affair was complete with press kits that fully described the purpose of the program and gave details on the camera equipment aboard.

That first launch was unsuccessful. Not long thereafter, a national policy decision drew a security screen around the project. The Air Force since that time has been restricted to post-launch announcements identifying *SAMOS* only as a "classified payload." The very word *SAMOS* became taboo. Military officers present with newsmen at the first launch are forbidden to speak it.

Just what was this idiocy supposed to accomplish? Presumably, it could be taken as an *ex post facto* gracious gesture to the Soviet Union if the U.S. stopped being so blatant about flying reconnaissance satellites across that nation. So the U.S. obligingly made a liar of itself by pretending such a program did not exist. The clumsy effort to undo what already had been done also in plain view of the world press and public made fools out of a number of people, some of whom still don't realize it and some of whom still are acutely uncomfortable about it.

Just what did this opera bouffe performance actually accomplish? Insofar as the Soviet Union is concerned, nothing. Soviet leaders talk about the U.S. *SAMOS* project by name and openly acknowledge the existence of its Russian counterpart. Premier Khrushchev at one point even offered to swap photographs.

What it *has* done is confront U.S. policy-makers with an imponderable situation in regard to public information policies on *MOL*. If one refuses to acknowledge the use of unmanned satellites to carry out reconnaissance activities over the Soviet Union and other areas of the world, then how does one treat a military manned satellite program aimed at proving a man can better do the same job?

Make no mistake about it, one of the prime purposes behind the *MOL* project is to do just that. To its credit, DOD has not made much of an effort to hide this in its discussions of *MOL* to date. But it is rapidly approaching the day when a question about camera equipment can be answered, unless there is a change of policy, only by a blank stare.

Too much of the discussion in favor of a partially open *MOL* public information policy centers around the question of whether it is possible to conceal such major events as manned spacecraft launches. That begs the question. The true question is whether such an attempt at concealment is right and proper. We say it is not.

A START ON A CORRECT *MOL* public information program should be made immediately by taking *SAMOS* off the dirty-word list and bringing it back out in the open. To do otherwise is to keep the U.S. in the position of accepting reconnaissance as something offensive, in the most literal sense. It is not. The U.S. conducts reconnaissance over the Soviet Union for its own protection against a closed society. It should not be afraid to acknowledge that fact.

Since the Russians already are discussing *MOL* as a military reconnaissance vehicle (see p. 17), it seems illogical for the U.S. to attempt another *ex post facto* effort at concealment.

Except in cases where release of detailed information on specific pieces of equipment or specific accomplishments is necessary, there should be an open-door public information policy on *MOL*. The program, because of sensitive areas, cannot be as open as the NASA manned program, of course. But there is no reason for *MOL* to be shrouded under more secrecy than, say, the *X-15* project.

Newsmen have been allowed to examine the *X-15*, attend launches, monitor the flights and interview the pilots at length after landing. Non-classified engineering data has been available to the trade press.

It can be said that the *X-15* is a joint research program, not an Air Force operational project. But so, in many ways, is *MOL*. Efforts to over-classify the program will bring only a contempt for security procedures that will endanger the truly sensitive areas of the project.

Whether a frank admission of past mistakes and a clean charting of an open future can be undertaken by an Administration whose Pentagon press secretary publicly proclaims the Government's right to lie, whose record of frankness in the Dominican Republic and Vietnam is badly besmirched and whose President is so overly sensitive to press criticism is an entirely different question.

William J. Coughlin

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Communication System Analysis Engineers

Conceptual design, analysis and synthesis of wide variety of digital and analog communication systems, employing coding, modulation, and statistical communication theory. Systems include integrated coherent-carrier systems, phase lock demodulation (restrictive/non-restrictive), communication satellites and deep space probes. MSEE or PhD.

Signal Processing Engineers

Design and development of sophisticated communication systems and components. Signal conditioners, analog and digital encoding and decoding, modulation tracking and carrier tracking phase lock loops, and multiphase modulation are involved in tracking, telemetry and command equipment which includes but is not limited to space applications. BSEE or MSEE.

Telemetry Circuit Design Engineers

To design a wide variety of analog and digital signal processing circuits for spacecraft digital telemetry equipment. Experience should relate to the design of analog-to-digital converters, analog and digital multiplexers, logic and data storage. Familiarity with microelectronics desirable. BSEE or MSEE.

Telemetry System Engineers

Experienced in the functional and logical design of analog and digital telemetry systems. Familiarity with design, development, application and evaluation of spacecraft instrumentation systems. Experienced in the design of data systems to interface with a wide variety of data sources including scientific experiments, and engineering measurements.

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missiles and rockets

THE WEEKLY OF ADVANCED TECHNOLOGY

FIFTH ANNUAL NASA ISSUE

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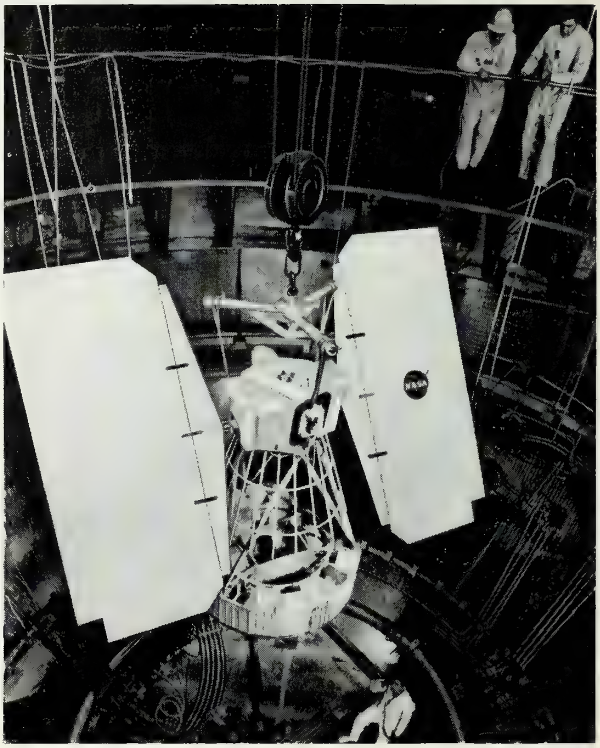

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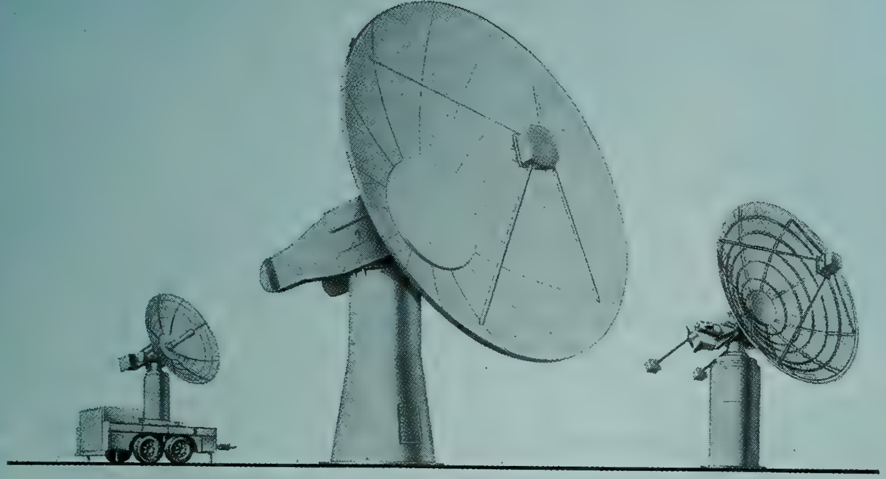

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Volume 17, Number 22 November 29, 1965

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THE COVER

Static firing of Saturn S-IVB stage at Sacramento, Calif. The Douglas stage is to be launched for the first time on a NASA Saturn IB in January, as the space agency moves into a new phase of launch vehicle qualification. M/R's fifth annual NASA issue, highlighting new funding for new programs, begins on page 35.

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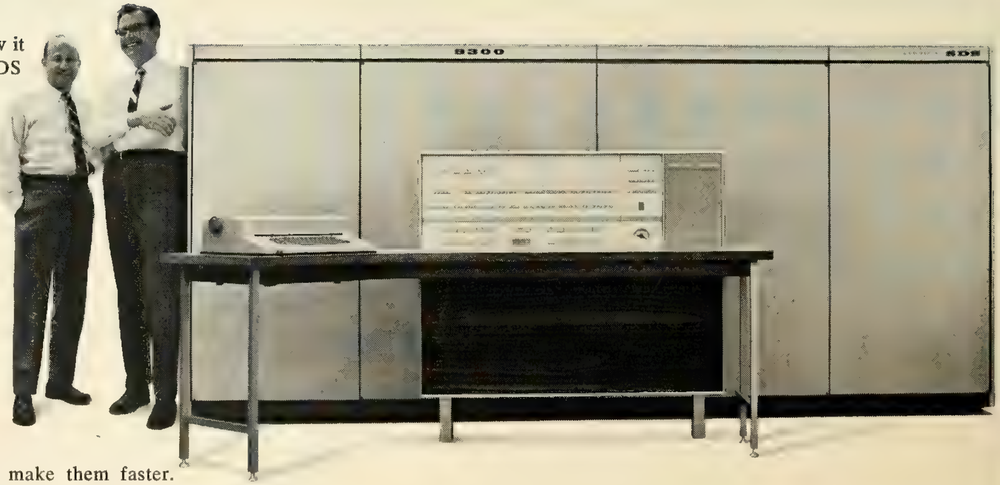
To make computers as good as these you've got to be simple-minded.



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SDS computers are simpler than other people's. They do the job with fewer circuits. Not nearly as many parts.

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We've found a lot of people who are willing to pay less money for computers that do more work.

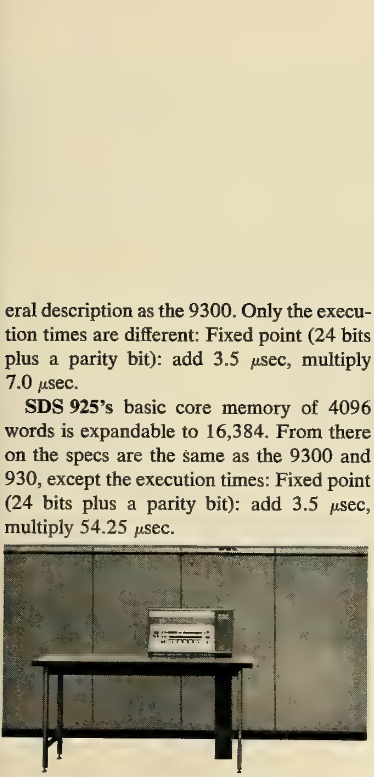
We make these six real-time computers and a lot of stuff to go with them:

SDS 9300 is our biggest. It has a basic core memory of 4096 words, expandable to 32,768 words, all directly addressable. One standard and any number of optional buffered input/output channels with rates to 572,000 words per second. Input/output simultaneous with computation up to 1024 levels of priority interrupt. Memory cycle time 1.75 μsec. Execution times, including all addressing and indexing: Fixed point (24 bits plus a parity bit): add 1.75 μsec, double precision add 3.5 μsec, multiply 7.0 μsec, shift (24 positions) 5.25 μsec. Floating point (39-bit frac., 9-bit exp.): add 14.0 μsec, multiply 12.25 μsec.

SDS 930 is next. Same memory and gen-

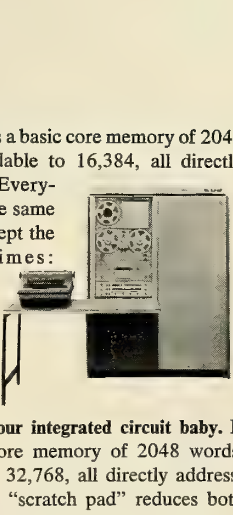
eral description as the 9300. Only the execution times are different: Fixed point (24 bits plus a parity bit): add 3.5 μsec, multiply 7.0 μsec.

SDS 925's basic core memory of 4096 words is expandable to 16,384. From there on the specs are the same as the 9300 and 930, except the execution times: Fixed point (24 bits plus a parity bit): add 3.5 μsec, multiply 54.25 μsec.



SDS 920 has the same memory capacity and priority interrupt as the 925. One standard and one buffered I/O channel with rates to 62,500 words per second. Memory cycle time 8.0 μsec. Execution times: Fixed point (24 bits plus a parity bit): add 16.0 μsec, multiply 32.0 μsec.

SDS 910 has a basic core memory of 2048 words, expandable to 16,384, all directly addressable. Everything else is the same as the 920 except the execution times: Fixed point (24 bits plus a parity bit): add 16.0 μsec, multiply 248.0 μsec.



SDS 92 is our integrated circuit baby. It has a basic core memory of 2048 words, expandable to 32,768, all directly addressable. Memory "scratch pad" reduces both program size and execution time. Hardware index register; indexing requires no additional time. One standard and any number of optional buffered I/O channels with rates to 572,000 words per second. Up to 256 levels of priority interrupt. Memory cycle time 1.75 μsec. Execution times, including all accesses and indexing: Fixed point (12 bits plus a parity bit): add 3.5 μsec, multiply 8.75 μsec, divide 22.75 μsec.

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The PCM multiplexer/encoder reflects the unchallenged leadership enjoyed by EMR in developing telemetry systems and products . . .

letters

The Magic Trees

To the Editor:

Your Oct. 11 editorial, "The Magic Trees," makes me wonder if you and President Beardsley Graham of Spindletop Research were talking about the same kind of trees.

The impression left by your comments on the impact of defense and space R&D expenditures on economic growth is that anyone who questions the benefits of the expenditures is jeopardizing national defense. This impression represents an injustice to Mr. Graham's ideas.

Mr. Graham makes a very significant and valid point that some of the space R&D funds now being sprinkled around by the Government could have more benefit to the economy if they were directed toward non-space goals. In other words, strengthen the country by supporting economic goals as well as political and military goals.

The fact that it is difficult to identify and trace by-products of space technology does not invalidate Mr. Graham's thoughts. Further, you cite no facts that support your contention that the current level of defense and space expenditures are not reducing the rate of economic growth.

I am sure that Mr. Graham and most Americans are all in favor of national defense. However, some Government R&D trees which are being sold to the taxpayers as "essential" for defense need to be pruned to produce high-quality fruit. Otherwise, we may find that we have grown far too many scrub oaks rather than giant redwoods.

James A. Warren
Booz, Allen & Hamilton, Inc.
Chicago

Back Issues Available

To the Editor:

Since 1956 I have been a subscriber to MISSILES AND ROCKETS. For some unexplained reason I could never bring myself to throw away an M/R once I finished reading it. As a result I am the holder of just about every copy since you first started circulation.

At this point in time I have convinced myself to part with this collection of past accomplishments and failures in the world of M/R. I will terminate this letter by asking: Are my magazines of any value to someone other than the trash man?

Primo Cucchiella
7907 Wallace Road
Baltimore, Md. 21222

We hope so. Interested readers please note.—Ed.

'Wrong' Peterson

To the Editor:

As a tribute to your circulation and readership, I have been swamped with queries regarding "my" new position at Scientific Data Systems.

A blurb in your Names in the News column for Nov. 15 started the whole thing: "Jack Peterson. Named director of technology for Scientific Data Systems . . ."

I'd appreciate it if you would mention this coincidence so that I can reassure my customers that I am still generating technical manuals and parts lists at the same old stand in Sarasota.

My congratulations to the "other" Jack Peterson on his new position, but I do wish he'd use an initial. If the initial turns out to be an "E" also, perhaps we can draw straws for JEP No. 1 and JEP No. 2.

Jack E(dward) Peterson
President
Peterson Publishing Company
Sarasota, Fla.

Dan Cole on Space

To the Editor:

I'd like you to know how *much* I appreciated Mr. Don Cox' letter about Dandridge Cole (M/R, Nov. 15, p. 6)—particularly that paragraph (quoting Cole) on space. After I'd read it I'd have sworn it wasn't prose but poetry. It took me straight back to that great poem of John Magee ("High Flight").

You're doing a fine job with your "letters" and I want you to know it's appreciated, even if I lack the nerve to emote in public.

(Name Withheld on Request)
Cocoa Beach, Fla.

Nuclear Rockets

To the Editor:

Praises be that Dr. Welsh, a real space authority *within* the Government, has spoken out against our shortsightedness in failing to plan adequately for development of nuclear rockets. After all, they are the *sine qua non* of significant exploration of space beyond the Moon.

Fred Mandelbaum
Chicago

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The Countdown

WASHINGTON

Surveyor Falls Further Behind Schedule

Surveyor program to soft-land a spacecraft on the Moon now is about three years behind schedule. Initial announcement of the project said first launch would be in 1963. Jet Propulsion Laboratory disclosed last week that first launch now cannot be made until next May at the earliest. Latest delay—with the launch being set back from the last quarter of this year—is blamed on minor instrumentation and spacecraft problems.

NASA Asks Bids on Broadcast Satellite

NASA has asked firms to submit bids within 45 days on a feasibility study of a radio broadcast satellite. Two satellites will be considered in the study, one transmitting in the HF band and the other in the FM band. Two companies will be selected to perform parallel six-month studies. The satellite could be used for direct broadcast to homes in the event local radio stations were knocked out by a nuclear blast or other disaster.

Project 489L Work Is Completed

Work on Air Force 489L project, the Northern Area Communications System, now is complete. It is said to be the longest range and most powerful tropospheric scatter communications system in the Free World. The FM system links Thule AFB in Greenland with the Hall Beach site in Northwestern Canada, a distance of about 587 mi. Philco was prime contractor for the system, which includes a 100,000-watt transmitter and four parabolic antennas, two at each site.

Congress Readies New Reports

Senate Space Committee has prepared a draft report on its findings on post-*Apollo* projects. Full committee approval will be sought early in the new session. Also expected soon after Congress reconvenes in January is the report of the House Military Operations subcommittee on certain differences of opinion between Dept. of Defense, industry contractors and the General Accounting Office. This document now is in the hands of the full Government Operations Committee. Some members are said to object to the conclusions.

ISIS Blown Off Schedule

Launch of the *ISIS X,* Canadian ionospheric satellite to be orbited by NASA, now is set for Nov. 30. The Nov. 24 launch was scrubbed last week when 130-knot winds were recorded at altitude above the Western Test Range.

Pioneer Launch Off Until Next Year

First launch of the *Pioneer* solar probe series is slipping into the first quarter of next year. Minor technical problems are blamed. Four flights are scheduled in the series but approval of an *Extended Pioneer* series is expected.

INDUSTRY

U.S. Team Heads Vietnam Construction

Top Army generals estimate construction work to support U.S. operations in Vietnam is running at about $125 million annually. About $4-5 million of this is being spent each month by the Army Corps of Engineers. Biggest chunk, however, goes to a team of U.S. contractors at work in Vietnam. The major firms include Raymond International, Morrison-Knudson, J. A. Jones and Brown & Root.

Here They Come Again

Industry firms are under Congressional scrutiny even during the current recess. Space Sciences and Applications subcommittee chairman Joseph Karth (D-Minn.), for example, is scheduled to visit Boeing/Seattle Tuesday to look into the *Lunar Orbiter* program, then going on to Southern California for another probe into JPL and Hughes Aircraft work on *Surveyor*. Says Space Committee chairman George P. Miller (D-Calif.): "We've got to keep checking on them to keep them moving along."

INTERNATIONAL

French Satellite Launches Imminent

French launch of the *A-1* satellite aboard a *Diamant* booster from the Hammaguir base in North Africa has turned into a race with American launch of the French *FR-1* satellite aboard a *Scout* at Vandenberg AFB. French space agency officials are hopeful that the all-French project will put up that nation's first satellite. Although assembly of the three-stage *Diamant* and the satellite has been completed, there are several unknowns. Separation of the second and third stages of the *Diamant* has never been accomplished, nor has orbiting of the third stage.

Meanwhile, Back at Vandenberg . . .

The French *FR-1* satellite, flown to the U.S. aboard Air France, is being readied for an early December launch by NASA. With Gen. de Gaulle anxious to have a French satellite in orbit before the forthcoming elections, a failure at Hammaguir will not affect the *FR-1* schedule. There is a backup *Diamant* booster at the North African base which can be used for a second *A-1* attempt. If the first flight is successful, however, that booster will be used to lift the *D-1A* scientific satellite of CNES, the French space agency, sometime in January. A string of successes would mean three French satellites up by the end of January, moving that nation quickly into third place behind the U.S. and Russia on number in orbit.

Plowden Committee Report Due in U.K.

The long-awaited report on the future of the British aircraft industry by the Plowden Committee is due for publication before Christmas. The report, nearly ready to go to Minister of Aviation Roy Jenkins, may recommend further mergers or even elimination of some firms. Indications are that the United Kingdom will go ahead with some space research on its own, possibly with the *Black Arrow* all-British booster.

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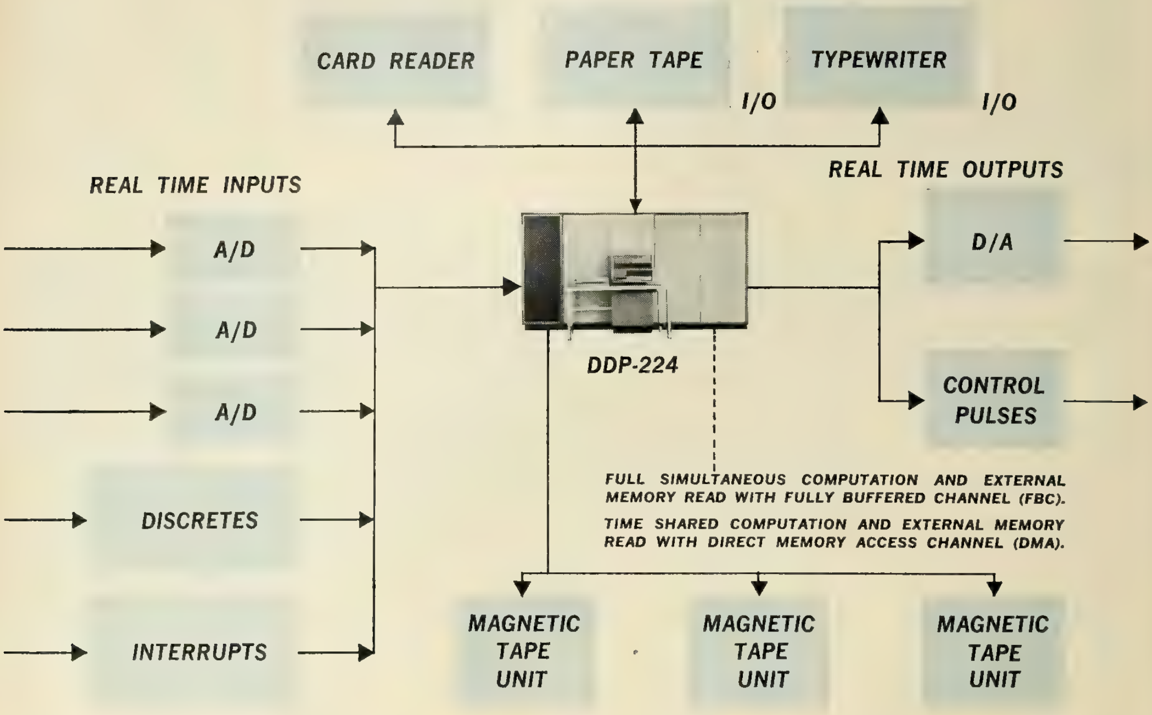

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First Sprint Pop-up Test Successful

Successful test of the "pop-up" launch technique for the *Sprint* missile at White Sands Missile Range, NM., has also signaled the start of an extensive guidance system test phase for the anti-missile weapon.

The flight, which is believed to have taken place during the week of Nov. 15, marked the first time *Sprint* has been fired using the gas ejection launch method from the newly completed underground test cell at White Sands. The cell closely resembles the operational silos that will house the missile if it is put into production.

The flight was also the first in which *Sprint's* radio command guidance system was tested.

Sources close to the project are optimistic about progress in both the launch and guidance areas for *Sprint*. Although the actual silo-launch was a first, the launch technique, in which a gas-driven piston is used to eject the missile from the silo prior to ignition of the first of two solid propellant motors, is an outgrowth of the *Polaris* program and has also been tested several times by the Martin Co., *Sprint* prime contractor, using inert missiles.

Late last month (M/R, Nov. 8, p. 9) the first launching of the *HIBEX* (high-acceleration experimental missile booster) was also made from an underground test cell. In the *HIBEX* technique the missile booster is ignited in the silo. *Sprint* project sources say they are watching that development closely and feel there may be some future application of the *HIBEX* launch technique to *Sprint*. The major advantage in using the *HIBEX* technique, they say, would not be in gaining any intercept time but in simplifying the launch mechanism and thus adding reliability. Since no rapid re-use of the silo is planned in the A-ICBM operational concept, damage to the silos caused by motor fire is apparently no problem.

Planners stress, however, that *HIBEX* is still experimental, that there are no current plans to change the *Sprint* launch concept, and that the more conservative approach chosen for *Sprint* reflects its potential operational status.

The major unknown in adapting the *HIBEX* technology is the effect of the very high acceleration on the missile and its components. Though both are very-high-speed missiles, *HIBEX* accelerates several times faster than *Sprint*, which is known to accelerate at forces in excess of 100 g's.

Since *Sprint* is designed to maneuver in flight against maneuverable re-entry vehicles, or to switch targets after launch, the guidance system testing is expected to be intensive.

SPRINT is caught by high-speed camera during first launch from under ground.

The missile will be exercised at WSMR in conjunction with the *Nike-X* Multi-Function Array Radar (MAR) now operating there. There is no Missile Site Radar (MSR), which makes up the other major radar component of the *Nike-X* system at the New Mexico test range. *Sprint* will be fired only against simulated targets at WSMR.

The current test phase at WSMR is expected to last 12 to 18 months, according to informed sources, at which time the flight testing will be moved to the Kwajalein Island test complex in the Pacific. A complete *Nike-X* test complex is now under construction there, including both radars and underground launch cells for *Sprint*. The missile will also face its first intercept tests against real target vehicles from Kwajalein.

Sprint's maneuverability stems from the basic aerodynamic shape of the weapon, the four small control surfaces that ring its mid-section, and a thrust vector control system associated with the propulsion. In the test announced last week, both of *Sprint's* motors were fired in flight.

Sprint will also have anti-aircraft capability, but there is no plan at this time to use it for that role.

GEOS Put To Work

Operational programming of the *GEOS I* (*Explorer XXIX*) satellite was expected late last week following successful testing of its five geodesy experiments.

The 385-lb. satellite was launched Nov. 6 to study the Earth's size, shape, mass and variations in gravity. Its mission involves simultaneous operation of five optical and electronic geodetic-tracking systems to provide measurements for a more precise model of the Earth's gravitational field and aid scientists in mapping a world coordinate system.

Lockheed Tops DOD Contractor List

Lockheed Aircraft Co., for the fourth consecutive year, leads the list of 100 top prime contractors for the Dept. of Defense.

The Lockheed Fiscal Year 1965 total of $1.715 billion was the second highest value ever received by a single DOD contractor, trailing only the $2.131 billion awarded to the Boeing Co. in Fiscal Year 1958. The Lockheed figure accounts for 7.1% of the total amount of DOD business done during FY '65 with U.S. companies.

General Dynamics Corp., in placing second to Lockheed for FY '65, moved up from the fifth spot it held in FY '64. The firm received 4.9% of the total.

McDonnell Aircraft Corp. maintained its hold on third place in FY '65, representing 3.5% of the total. However, the dollar value of the firm's contracts dipped $300 million below its total in FY '64.

General Electric Co. made a sharp advance—moving from sixth place to fourth this year, mostly on the strength of aircraft engine contracts, which helped lift the firm's FY '65 contracts' value to $824.3 million, or 3.4% of the total.

North American Aviation, Inc., rounded out the top five with $745.8 million.

The list of 100 top prime contractors, reflecting cumulative totals of individual contracts valued at $10,000 or more, accounted for 68.9% of the U.S. total in FY '65. This was 4.5% below the level achieved last year by the top 100, according to DOD statistics, and was the lowest percentage since FY '57. Furthermore, the first 25 companies received 4.7% less than in FY '64.

DOD said the decline in the total awarded to the prime contractors reflects primarily a FY '65 decrease of $1.6 billion in missile and aircraft contracts. As a corollary to this decline, the percentage of all prime contracts awarded to small business jumped from 18% in FY '64 to 20.3% in FY '65. Small business firms also accounted for 40% of the subcontracts awarded by the larger prime contractors.

The FY 1965 list contains 17 companies which did not appear in the FY '64 rankings. Thirteen of these are found in the last 25 positions. Two of the new firms—Todd Shipyards Corp. and Ogden Corp. (parent company for Avondale Shipyards, Inc.)—moved to the top 50.

DOD LIST OF FY 1965 100 TOP PRIME CONTRACTORS

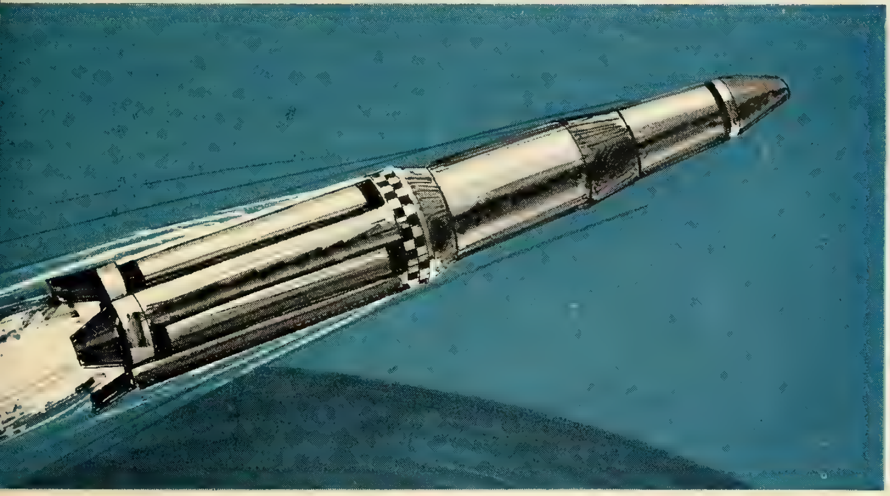
Rank	Companies	Millions of Dollars	Percent of U.S. Total	Cumulative Percent of U.S. Total
	U.S. Total	$24,177.9	100.0%	100.0%
	Total, 100 Companies	16,662.1	68.9	68.9
1.	Lockheed Aircraft Corp.	1,715.0	7.1	7.1
2.	General Dynamics Corp.	1,178.6	4.9	12.0
3.	McDonnell Aircraft Corp.	855.8	3.5	15.5
4.	General Electric Co.	824.3	3.4	18.9
5.	North American Aviation, Inc.	745.8	3.1	22.0
6.	United Aircraft Corp.	632.1	2.6	24.6
7.	American Telephone & Telegraph Co.	587.6	2.4	27.0
8.	Boeing Co.	583.3	2.4	29.4
9.	Grumman Aircraft Engineering Corp.	353.4	1.5	30.9
10.	Sperry Rand Corp.	318.4	1.3	32.2
11.	Martin-Marietta Corp.	315.6	1.3	33.5
12.	Ford Motor Co.	312.0	1.3	34.8
13.	General Tire & Rubber Co.	302.0	1.2	36.0
14.	Raytheon Co.	293.4	1.2	37.2
15.	Hughes Aircraft Co.	278.3	1.2	38.4
16.	Ling-Temco-Vought, Inc.	264.7	1.1	39.5
17.	Westinghouse Electric Corp.	260.9	1.1	40.6
18.	Northrop Corp.	255.9	1.1	41.7
19.	General Motors Corp.	254.4	1.0	42.7
20.	Bendix Corp.	234.9	1.0	43.7
21.	Avco Corp.	234.2	1.0	44.7
22.	General Telephone & Electronics Corp.	222.5	0.9	45.6
23.	Kaiser Industries Corp.	218.8	0.9	46.5
24.	Radio Corp. of America	213.9	0.9	47.4
25.	International Telephone & Telegraph Corp.	206.7	0.8	48.2
26.	Todd Shipyards Corp.	196.6	0.8	49.0
27.	Textron, Inc.	195.7	0.8	49.8
28.	Litton Industries, Inc.	189.9	0.8	50.6
29.	International Business Machines Corp.	186.2	0.8	51.4
30.	Newport News Shipbuilding & Dry Dock Co.	184.8	0.8	52.2
31.	Douglas Aircraft Co.	170.1	0.7	52.9
32.	Standard Oil Co. (New Jersey)	164.0	0.7	53.6
33.	Pan American World Airways, Inc.	157.7	0.6	54.2
34.	Collins Radio Co.	141.1	0.6	54.8
35.	Thiokol Chemical Corp.	136.2	0.6	55.4
36.	Texaco, Inc.	124.2	0.5	55.9
37.	FMC Corp.	124.0	0.5	56.4
38.	Massachusetts Institute of Technology	123.7	0.5	56.9
39.	Standard Oil Co. (Calif.)	114.8	0.5	57.4
40.	Hercules Powder Co.	101.3	0.4	57.8
41.	General Precision Equipment Corp.	100.5	0.4	58.2
42.	Socony Mobil Oil Co.	85.5	0.4	58.6
43.	Goodyear Tire & Rubber Co.	82.5	0.4	59.0
44.	Honeywell, Inc.	82.5	0.4	59.4
45.	Ogden Corp.	82.2	0.3	59.7
46.	Chrysler Corp.	80.9	0.3	60.0
47.	TRW, Inc.	79.6	0.3	60.3
48.	Aerospace Corp.	77.5	0.3	60.6
49.	Continental Motors Corp.	77.4	0.3	60.9
50.	du Pont (E.I.) de Nemours & Co.	70.6	0.3	61.2
51.	Republic Aviation Corp.	70.1	0.3	61.5
52.	Signal Oil and Gas Co.	69.1	0.3	61.8
53.	Magnavox Co.	60.4	0.3	62.1
54.	Asiatic Petroleum Corp.	57.8	0.3	62.4
55.	Western Union Telegraph Co.	51.8	0.2	62.6
56.	Eastman Kodak Co.	50.8	0.2	62.8
57.	Lear-Siegler, Inc.	49.5	0.2	63.0
58.	Olin-Mathieson Chemical Corp.	49.4	0.2	63.2
59.	Curtiss-Wright Corp.	49.3	0.2	63.4
60.	System Development Corp.	48.9	0.2	63.6
61.	Johns Hopkins University	48.5	0.2	63.8
62.	Bath Iron Works Corp.	47.9	0.2	64.0
63.	Bethlehem Steel Corp.	47.9	0.2	64.2
64.	Sverdrup & Parcel, Inc.	47.0	0.2	64.4
65.	Morrison-Knudsen Company, Inc.; Utah Construction & Mining Co.; Perini Corp.; and C. H. Leavell & Co.	46.6	0.2	64.6
66.	Texas Instruments, Inc.	43.8	0.2	64.8
67.	Gyrodyne Co. of America, Inc.	39.3	0.2	65.0
68.	Continental Oil Co.	39.2	0.2	65.2
69.	Control Data Corp.	39.1	0.2	65.4
70.	Mitre Corp.	38.5	0.2	65.6
71.	Vitro Corp. of America	36.4	0.2	65.8
72.	International Harvester Co.	35.8	0.2	66.0
73.	Union Carbide Corp.	35.2	0.2	66.2
74.	Kaman Aircraft Corp.	35.1	0.1	66.3
75.	Cutler-Hammer, Inc.	34.5	0.1	66.4
76.	Standard Oil Co. (Indiana)	33.2	0.1	66.5
77.	Norris-Thermador Corp.	31.4	0.1	66.6
78.	Hayes International Corp.	31.2	0.1	66.7
79.	Teledyne, Inc.	30.7	0.1	66.8
80.	Stanford Research Institute	30.7	0.1	66.9
81.	Burroughs Corp.	30.4	0.1	67.0
82.	Gulf Oil Corp.	30.3	0.1	67.1
83.	Cities Service Co.	30.0	0.1	67.2
84.	Flying Tiger Line, Inc.	29.9	0.1	67.3
85.	Richfield Oil Corp.	29.3	0.1	67.4
86.	Firestone Tire & Rubber Co.	28.8	0.1	67.5
87.	White Motor Corp.	28.6	0.1	67.6
88.	Ryan Aeronautical Co.	26.9	0.1	67.7
89.	Standard Kollsman Industries, Inc.	26.9	0.1	67.8
90.	Atlantic Research Corp.	26.7	0.1	67.9
91.	Motorola, Inc.	26.7	0.1	68.0
92.	Condec Corp.	26.3	0.1	68.1
93.	Chamberlain Corp.	25.9	0.1	68.2
94.	Koppers Co., Inc.	25.9	0.1	68.3
95.	Union Oil Co. of California	25.4	0.1	68.4
96.	Dynalectron Corp.	24.9	0.1	68.5
97.	Rich (F.D.) Co., Inc.	24.8	0.1	68.6
98.	Morrison-Knudsen Co., Inc.	24.7	0.1	68.7
99.	Webb (Del E.) Corp.	24.3	0.1	68.8
100.	Day & Zimmerman, Inc.	24.3	0.1	68.9

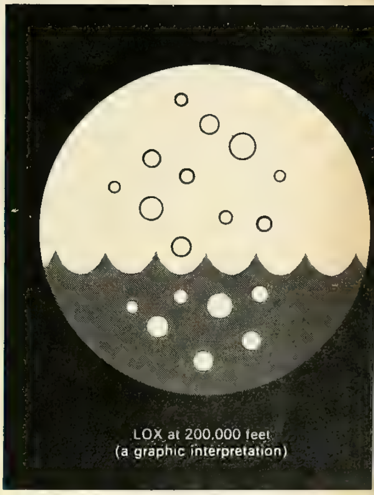
Objective:

To monitor the Saturn's LOX above 200,000 feet.

Achieved by another American Optical development:

Fiber-optics viewing system.





LOX at 200,000 feet
(a graphic interpretation)

The environment of the Saturn's liquid oxygen is cryogenic, explosive and subject to high vibration. In order to observe the behavior of LOX from lift-off to first-stage separation, a system having low weight and high reliability was developed by American Optical. The fiber-optics viewing system weighs less than 25 lb., has an optical resolution of 40 line pairs per mm, employs over 800,000 fibers in a 16-mm format, and survives pressures from .00082 to 14.7 psia under vibration in excess of 25 G's (sinosoidal and random). Reliability has been demonstrated by successful performance on four Saturn flights.

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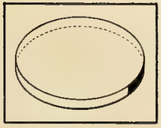

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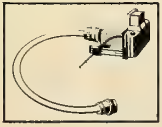

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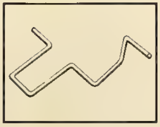

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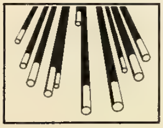

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Ambitious Gemini Flight Nears

NASA expects to attempt to set several new world manned spaceflight records with the *Gemini 7* flight, slated for launch Dec. 4 from Cape Kennedy.

If the two-man mission lasts the planned 14 days, it will give the U.S. new marks for total manhours in space, longest single manned space mission, total number of manned spaceflights, and longest time in space by a single astronaut during a single mission.

If *Gemini 6* is successfully launched and carries out a rendezvous with *Gemini 7*, it will also be the first time that two manned spacecraft have achieved rendezvous in orbit.

The *Gemini 6* blastoff is set for the ninth day of the *Gemini 7* flight at the earliest, and no later than the 13th day of the flight. Astronauts Frank Borman and James A. Lovell will be at the controls of *Gemini 7* and Astronauts Walter Schirra and Thomas Stafford will be the crew for *Gemini 6*.

Prime objective of the *Gemini 7* flight is to obtain data on the effects of 14 days of weightlessness on the astronauts. Main purpose of the later flight is to rendezvous with another object in space and gather data on the operation of systems used in such a maneuver.

Gemini 7 will double total U.S. manned spacecraft hours in space by adding 382 hrs. to the U.S. total of 381 hrs. and 52 min. and also double U.S. manhours in space by adding 764 hours to the total of 641½ hrs.

If both flights are successful, the two spacecraft will re-enter the Earth's atmosphere about three days apart. Recovery for both is planned in the South Atlantic.

The rendezvous attempt is scheduled to take place on the first day of the *Gemini 6* flight on the fourth revolution around the Earth. Almost all the maneuvers and thrust firing required to bring the spacecraft close together will be made by the *Gemini 6* spacecraft. Space aboard *Gemini 7* had to be conserved so that sufficient quantities of power and life-support equipment could be carried to sustain the 14-day mission.

Preparations for launch of the *Gemini 7* and *Gemini 6* spacecraft are back on schedule after striking McDonnell Aircraft Corp. technicians returned to their jobs at Cape Kennedy.

More than 200 McDonnell employees resumed work Nov. 23 after being pulled off their jobs Nov. 19 by the International Assn. of Machinists, St. Louis Local 837. The union agreed to a Labor Dept. request to send the Cape Kennedy members back to work, but continued its strike against McDonnell elsewhere.

A supervisory crew from McDonnell replaced workers at the Cape during the four-day walkout and performed critical tests on new fuel cells being tested for the *Gemini* flights. The work schedule for *GT-7* was revamped so that as much as possible could be accomplished without the striking McDonnell machinists.

ITT World Communications, Inc., is again hoping to provide the first live television coverage of the pickup of *Gemini* astronauts during the *GT-7/6* mission.

The firm has requested Federal Communications Commission approval to operate a portable ground station aboard the recovery ship, the USS Wasp. FCC, NASA and Navy approval had been given ITT for coverage of the *GTA-6* mission recovery, originally scheduled for October.

Surveyor Passes Drop Test

A successful drop test of *Surveyor* soft-landing subsystems was made at Holloman AFB, N.M., on Nov. 22. All objectives of the simulated lunar soft landing were accomplished, reported Jet Propulsion Laboratory, manager of the *Surveyor* project for NASA.

The *Surveyor* throttleable liquid engines, flight-control electronics, and descent radar lowered a test vehicle from about 1,400 ft. to 500 ft. At this altitude the sink rate was 5 ft. per sec. A parachute system was then deployed to lower the vehicle to the ground.

The test vehicle was initially suspended from a balloon. After the rocket engines were successfully ignited and the radar switched on, the vehicle was released to descend under the power of the rocket engines. Analysis of telemetry showed that all systems functioned as planned.

Luster Payload Flown

Fourteen U. S. and European experimenters are now analyzing particles collected by the *Luster* probe of the Leonid meteor shower. The results are expected within six months.

The *Luster* payload was launched Nov. 16 from the White Sands Missile Range with an *Aerobee* rocket, to an altitude of 100 mi. and recovered by parachute. Developed and built by Electro-Optical Systems under contract to NASA's Ames Research Center, the *Luster* payload deploys three 5.5-ft.-long aluminum arms covered with polished, mirror-perfect collection pans for some 200 seconds during the passage through the micrometeoroid-infested area.

These arms close for the return flight. The pans will be removed under carefully controlled conditions and shipped to the various labs involved for analyses. EOS experts believe the *Luster* vehicle can be used to gather lunar dust and other particles above the Earth's atmosphere in future flights as an adjunct to the *Surveyor* effort. The "Frank Buck" concept may prove to be successful after the analyses by the organizations participating in the recent flight.

Guest experimenters include the Air Force Cambridge Research Labs, NASA's Goddard Space Flight Center, the Geological Survey's Dudley Observatory, Max Planck Institute, National Center for Atmospheric Research, Birbeck College and other labs in Europe and the U.S.

The results of the analysis will probably take somewhat more than the initial six months to be made generally available.

Nelson Bill Due Hearings

Hearings on the bill introduced by Sen. Gaylord Nelson (D-Wis.) to authorize a $125-million program for the application of systems engineering techniques to various social and economic problems will be held when Congress reconvenes in January.

Meanwhile, a decision is expected soon from the new Department of Housing and Urban Affairs on a proposal by the State of California that Federal money be granted for a systems analysis approach to demonstrate the use of land as a function of Government, the identification of particular types of land, zoning, and the keeping of better records.

The proposal asks for $220,000, to be matched by $110,000 of California money, and involves a particular application of the findings in the Lockheed Missiles and Space Co. study.

According to Harold Walt, member of California Governor Edmund G. Brown's staff, meetings also are being held with Department of Health, Education and Welfare on another systems analysis proposal.

California is now readying a proposal to HEW for a systems analysis study of the state's social welfare programs. Walt also indicated that additional proposals based upon the studies performed by Aerojet-General, North American and Space-Gen-

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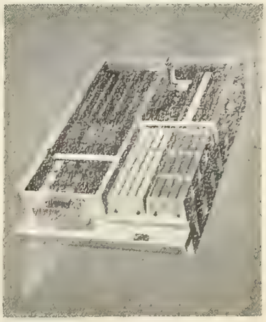
Raytheon's leadership in microminiaturized equipment design and packaging, plus proven experience with high-density memory systems, advanced integrated circuit applications and unique automated manufacturing techniques has enabled Raytheon to produce today's most sophisticated space vehicle guidance and navigation computer for the Apollo and LEM programs. This computer, shown at right, has a repertoire of 49 instructions and a fixed and scratch pad memory of 38,912 words. It occupies a volume of less than one cubic foot, weighs less than 70 pounds, and represents the highest packaging density to date.

Raytheon Space and Information Systems Division's continuous support of Massachusetts Institute of Technology on the Apollo, Polaris, and Poseidon programs demonstrates an ability to supply a wide range of advanced analytical, design and manufacturing talents for present and future demanding aerospace programs.

For additional information regarding Raytheon's activity in the field of advanced guidance computers, write to *Manager of Marketing, Raytheon Company, Space and Information Systems Division, Sudbury, Mass.*



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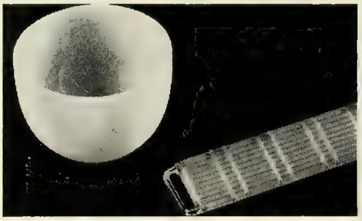

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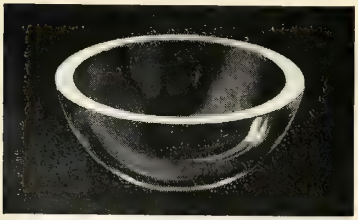

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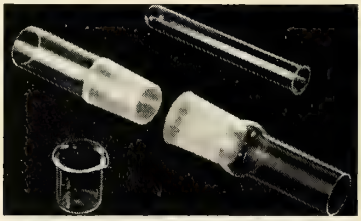

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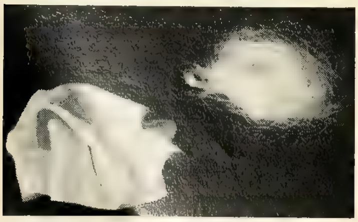

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eral would probably be made to the respective Federal agencies.

At a preliminary hearing held in Los Angeles, California Governor Edmund G. Brown said the Nelson bill has his "full support." Brown gave the Nelson delegation the advice, however, that political entities smaller than states should not be included in the competition for future Federal funds, although he indicated that some exceptions, such as New York City, might exist.

Brown explained his stand by saying that he regarded the projects "in the same category as the work we are doing in the space program." He added, "I think we have to regard this as a national program. These are national problems that observe no lines at all."

Brown also cautioned that "As you investigate the possibilities of systems engineering, you will hear claims made for it that put it in the class of sorcery. As a governor, I do not expect magic cures from the systems approach."

Saying that he would not abdicate his responsibility to a bank of computers, he pointed out that while "the models . . . can give us factual comparisons of the results we can expect from various approaches to problems, they cannot make decisions. What the systems engineers can do is construct a set of facts without bias or prejudgment. . . ."

Thomas C. Rowan, vice president and manager of the Advanced Systems Div. of System Development Corp., said that it "would be misleading to leave the impression that this is an inexpensive process. We have all become inured to the tremendous costs of solving a defense problem. I wonder if we are prepared for the total system cost implicit in the solution of problems such as air pollution, or waste disposal."

Rowan pointed out that SDC was the technical monitor for the state of California on the four contracts awarded to aerospace companies to study state problems, but that the determination of system prime objectives "cannot be left to the technologists alone."

He stressed that "this must be a joint effort between the elected officials, who are responsible to the public, and the specialists, who are attempting to develop the program. The purposes, uses and goals of any program must derive from the values and mores of the public," he said.

"Thus, some of the trade-offs implicit in the judgment to follow, or not to follow, a particular course of action are not necessarily subject to rational analysis. Therefore it is

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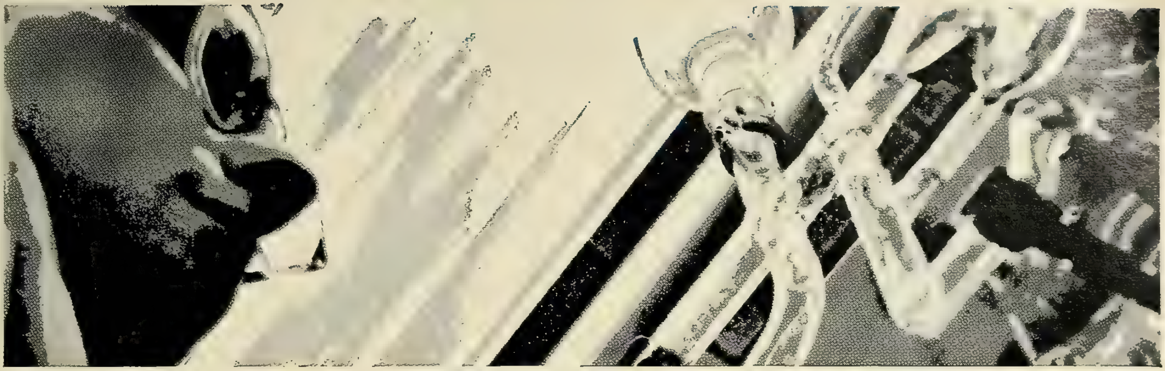

chemicals

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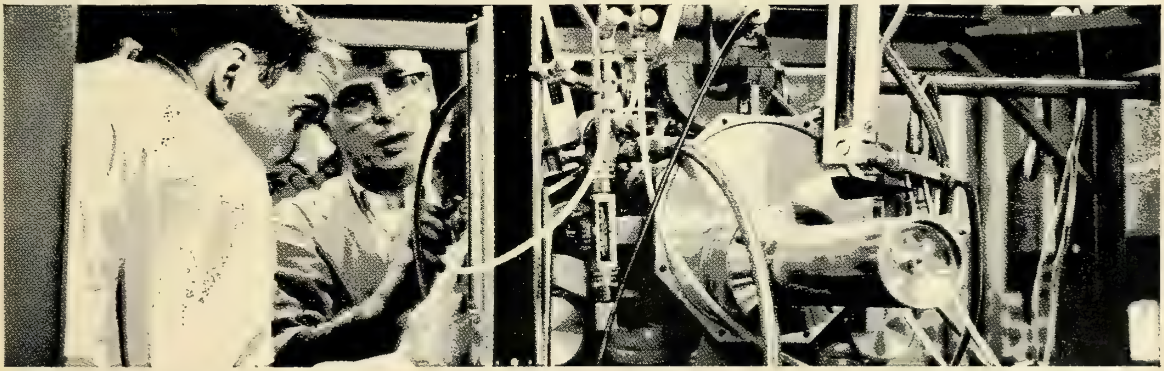

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imperative to remember that systems analysis is a technology that applies the scientific method to the allocation of limited resources among a variety of competing demands, given a set of objectives. In and of itself, it can not, nor is it intended to, determine those objectives."

AEC Has Oceanology Program

The Atomic Energy Commission is initiating a specifically designated nuclear reactor program for oceanographic auxiliary power systems and vehicle propulsion systems.

According to Dr. John A. Swartout, assistant general manager of the AEC for reactors, the oceanographic reactor program will be in the Division of Reactor Development and Technology. To provide capability for specific power systems as applications arise, the AEC's planning is divided into two power areas, he said. These are: 1) up to 2 megawatt electric primarily for auxiliary power (although he said there may be some propulsion needs in that range) and 2) above 2 megawatt electric primarily for vehicle propulsion.

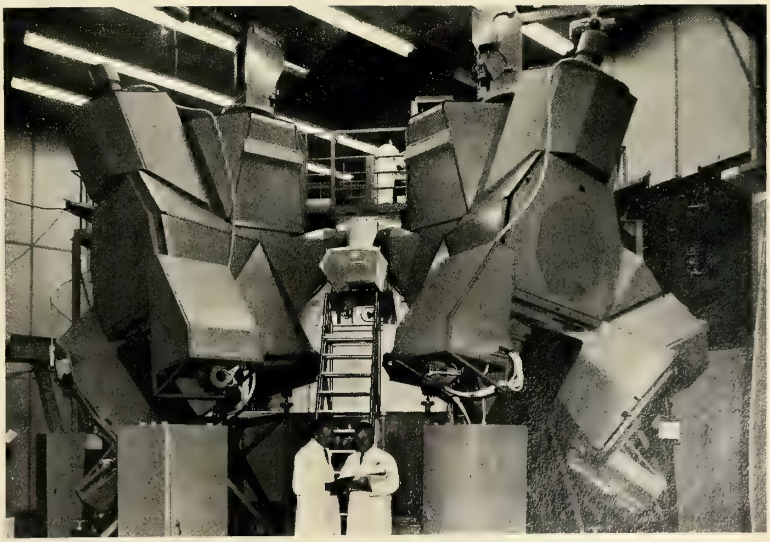
- **NR-1 vehicle**—Another aspect of AEC's program is the development in the Division of Naval Reactors of a deep-submergence and ocean engineering vehicle (NR-1), which will be able to operate at maximum depth and speed for weeks at a time with limitations only on the food and water supplies it can carry.

The vehicle will make detailed studies and mapping of the ocean bottom, obtain detailed temperatures and current data, and locate and retrieve objects of commercial, scientific and military value, Swartout said. He added that it will have lights and portholes for observation and photography.

AEC's funding over a period of four years will be about $7 million, Swartout said. This cost does not include the reactor.

The AEC official said that the technology obtained from the development of this particular vehicle will provide the basis for future oceanographic research vehicles. Nuclear energy fits into the equipment technology needs of the organizations most interested in oceanography, he pointed out.

A wide market exists for such units, Swartout indicated. For example, he pointed out that if the Coast Guard replaced just its 5- and 30-watt battery systems with nuclear power, they would require more than 11,000 nuclear devices.



Apollo Training Simulator Due at MSC

MULTIMILLION-DOLLAR Apollo Mission Simulator, primary training system for first U.S. lunar astronauts, will arrive this week at NASA's Manned Spacecraft Center, Houston, with a second unit scheduled to go the Spacecraft Center at Cape Kennedy. Shown here are the visual system and Command Module. The total equipment will simulate the Apollo spacecraft and its mission, including visual sightings in space. The second Apollo simulator, and two LEM simulators, are under construction by the developer, General Precision, Inc.'s Link Group, under contract to North American Aviation, Inc.

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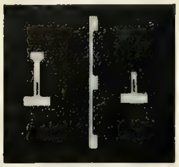
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● **Isotopic power**—The AEC also will establish a program soon to study the desirability and feasibility of radioisotope units in the thousands-of-watts range, Swartout revealed.

The high-powered 1- to 5-kw systems, he said, could find use in heavier applications such as undersea mining and exploration, and as power sources for manned undersea platforms. For the latter, he pointed out, the devices could provide both electrical and thermal power. The waste heat from the system could be used for heating the installation and for supporting services such as cooking and washing.

Experience proves the feasibility and attractiveness of isotopic power for oceanographic applications, he said, although there have been some normal development problems.

The next step in this area is to develop a second generation of units with higher outputs than those now operating (which are mostly in the 60-watt area). SNAP 21 and 23 will be entering development testing within a year, he said.

● **SNAP 21**—SNAP 21 is capable of operating under pressures of up to 10,000 psi with absolute containment of the fuel for a minimum of 300 years. A 10-watt system in the SNAP 21 program is in an advanced stage of development, and will undergo performance testing in the winter of 1966.

Design of higher power versions of the SNAP 21 generator (20 and 60 watts) will soon be initiated, with demonstration units following, Swartout said.

● **SNAP 23**—Also, in the winter of 1966 the 60-watt SNAP 23, which weighs only 1,000 lbs. compared with the SNAP 7B weight of 4,600 lbs. for the same power output, will be tested. Follow-on units in the 25- and 100-watt range are scheduled for completion during 1967 and 1968, he said.

Besides the AEC's efforts to develop higher powered isotopic units, Swartout added, it is initiating a program to provide generators in the 100 to 600-milliwatt level with a minimum lifetime of 18 months. Prototype fueled units may be available in 1967, he said.

Swartout also said that the AEC is considering use of Pu-238 and a variety of other isotopes such as Pm-147, Ce-144, Cs-137 and Co-60, for oceanographic purposes, some of them already used in space. These alpha emitters are attractive because they have high power densities and require relatively little shielding, he said. At the present, all of the oceanographic isotopic units are direct-conversion thermoelectric devices using lead telluride as the thermo-electric material and using a cheaper, more abundant beta emitter (Strontium-90) as fuel.

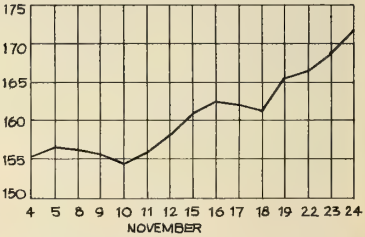
Swartout added that for the current fiscal year about $5 million is being budgeted by the AEC for land and sea auxiliary power system development, and the agency hopes for larger annual expenditures for the next four or five years.

Missile/Space Stock Index

The recently increased pace of the Vietnam war and continued talk of new weapons orders brought the Missile/Space Stock Index to still higher records.

At the beginning of last week, the Index topped the mark signifying a two-thirds rise since the first of the year, and Wednesday, Nov. 24, hit 170 for the first time.

The Index is compiled daily by the M/R Research Department from stock prices furnished by Merrill Lynch, Pierce, Fenner and Smith. The 19 companies in the Index are: Avco, Bendix, Boeing, Douglas, General Dynamics, General Precision, Grumman, Lear Siegler, Ling Temco Vought, Litton Industries, Lockheed, Martin, McDonnell, North American Aviation, Northrop, Raytheon, Thiokol, TRW, and United Aircraft.



These companies, bellwethers of the defense/aerospace field, meet the criteria of doing better than $200 million in sales each year, more than half of which is in the defense/space field, and being listed on the New York Stock Exchange. A detailed analysis of their performance this year is contained in MISSILES AND ROCKETS, Nov. 15, p. 36.

Shots of the Week

The Army announced on Nov. 19 that personnel of its *Nike-X* missile defense project successfully launched a *Sprint* anti-missile missile from an underground cell of the type conceived for operational use. The firing (see photo, p. 13) was from White Sands Missile Range, N.M.

● The Air Force launched a total

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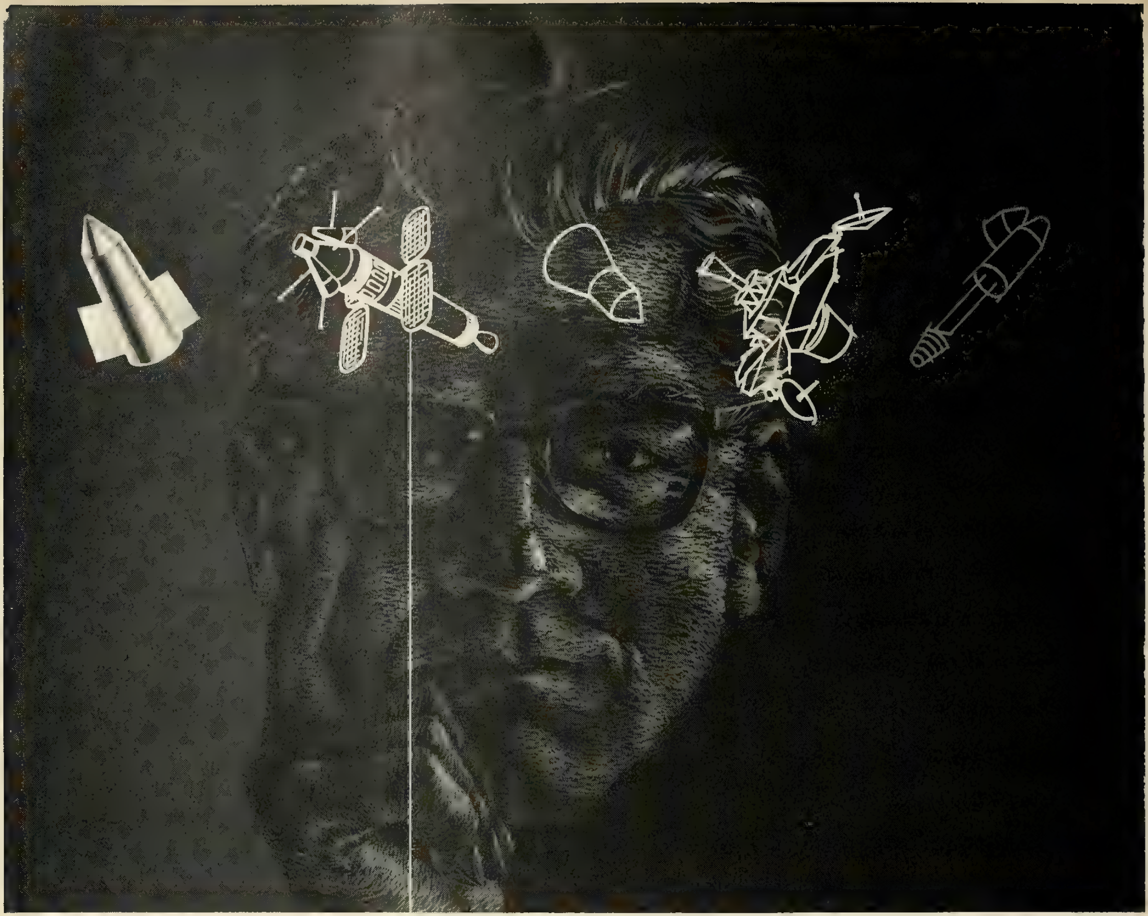

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of 22 vertical probe research rockets from the Aerospace Launch Facility at Eglin AFB, Fla., during the period Nov. 15-19. Rockets involved were the *Nike-Cajun, Arcas, Sparrow-Arcas, Nike-Javelin,* and *Honest John-Nike-Nike-Hydac.* Twenty of the shots were in support of International Quiet Sun Year scientific programs. One shot, aboard a Nike-Javelin, carried a modular payload package developed by the Defense Atomic Support Agency (M/R, Nov. 23, 1964, p. 24).

- An Aerobee rocket was used to launch a *Luster* vehicle from White Sands Missile Range, N.M., Nov. 16 (see item, p. 16; also, M/R, Nov. 23, 1964, p. 8).
- The Soviet Union on Nov. 23 launched Cosmos 96.

Longshot Wave Data Surprises

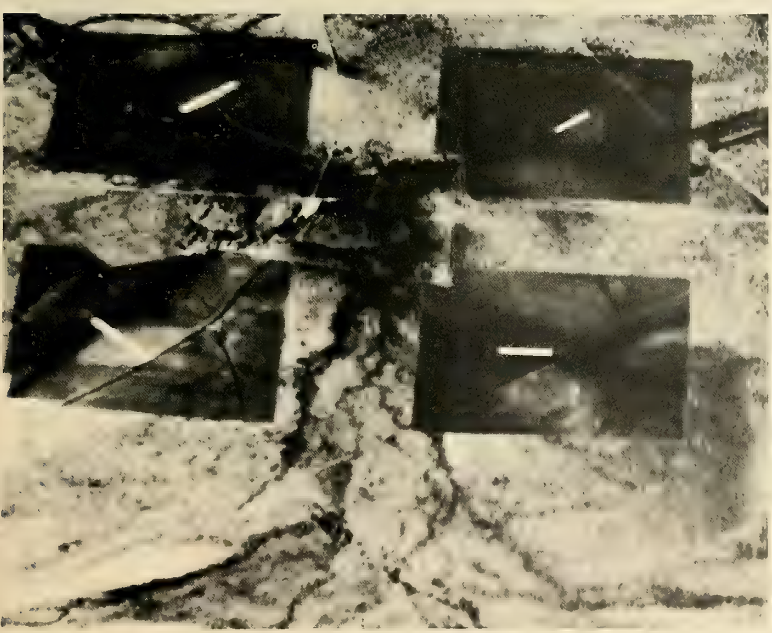
Early analysis of data from Project Longshot, the ARPA-sponsored detonation of an 80-kiloton nuclear fusion device 2,300 ft. deep in the Amchitka Island region of the Aleutians, shows that seismic waves emanating from the blast arrived at detection stations around the world several seconds earlier than had been predicted.

The travel times were even faster than recently corrected tables of seismic-wave travel characteristics. Scientists believe that this may have been caused by a pronounced siesmic-velocity anomaly in the crust and mantle of the Amchitka region, an area adjacent to the portion of the Soviet Union where 70% of its earthquakes occur.

Exact data on wave travel time are critical to pinpointing location of earthquakes or clandestine nuclear explosions. No further tests are planned in the project, according to ARPA. Scientists say all 525 channels of the new LASA detection array in Nevada recorded the test with strong signal-to-noise ratios.

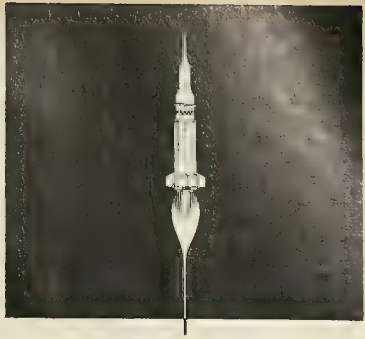
Weapon Test System Planned

An Air Force Weapons Effectiveness Testing (AFWET) Instrumentation System will be installed at the



Ground Markings for Gemini Vision Test

AERIAL PHOTO shows part of area near Laredo, Tex., used for visual acuity tests during Gemini 5 flight of Astronauts Gordon Cooper and Charles Conrad. Test for Gemini 7 Astronauts Frank Borman and James Lovell will differ in that there will be eight background areas of tilled soil in a matrix of two by four, rather than 12 in three parallel rows of four each for Gemini 5. White plastic rectangles will be narrower for GT-7 than for GT-5 experiment, which was partially unsuccessful because the powered-down spacecraft was tumbling at the time. Each rectangle or white line will have one of four basic orientations: north to south, northeast to southwest, east to west or southeast to northwest. The rectangles will be placed in tilled areas 2,000 ft. square. They will vary in length from 200 to 500 ft. Natural terrain and vegetation will separate the tilled areas.



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Apollo Seen Usable for Mars

An *Apollo* Command Module might well be used to carry men to Mars, a recent study by Lockheed Missiles & Space Co. indicates.

An investigation conducted by LMSC for the Mission Analysis Div. (MAD) at NASA's Ames Research Center concludes that an *Apollo* configuration would be suitable for reentry from a Mars mission at speeds up to 50,000 fps. This jibes with a previous MAD study which demonstrated that a swing-by past Venus would decelerate a returning Mars vehicle to 50,000 fps.

These findings may have a substantial effect on planning for the Mars mission. Earlier, it was widely believed that a lifting body or pointed-conical shape would be needed for planetary re-entry. If it can now be assumed that the cost of a Mars mission can be cut back by using *Apollo* rather than developing a new vehicle, the project may gain support. However, NASA officials say the commitment to the *Apollo* lunar landing is expected to put off for several years any firm plans for a manned Mars mission—and that in the meantime the technology may leapfrog over *Apollo*.

ARC Patents Tape-Fed Rockets

Two forms of tape-fed, solid fueled, micro-thrust rocket concepts have been patented by Atlantic Research Corp.

One patent (U.S. 3,210,931) involves miniature full-scale rockets mounted on tape and fed serially into a holding device, similar to machine-gun feeding. Each rocket is a complete motor with igniter, propellant and nozzle, all contained in an inch-long case.

The other patent (U.S. 3,210,930) covers a small rocket system in which the solid-propellant charges are in capsule form, "similar to caps for cap pistols," and are mounted on a moveable tape and fed from a drum

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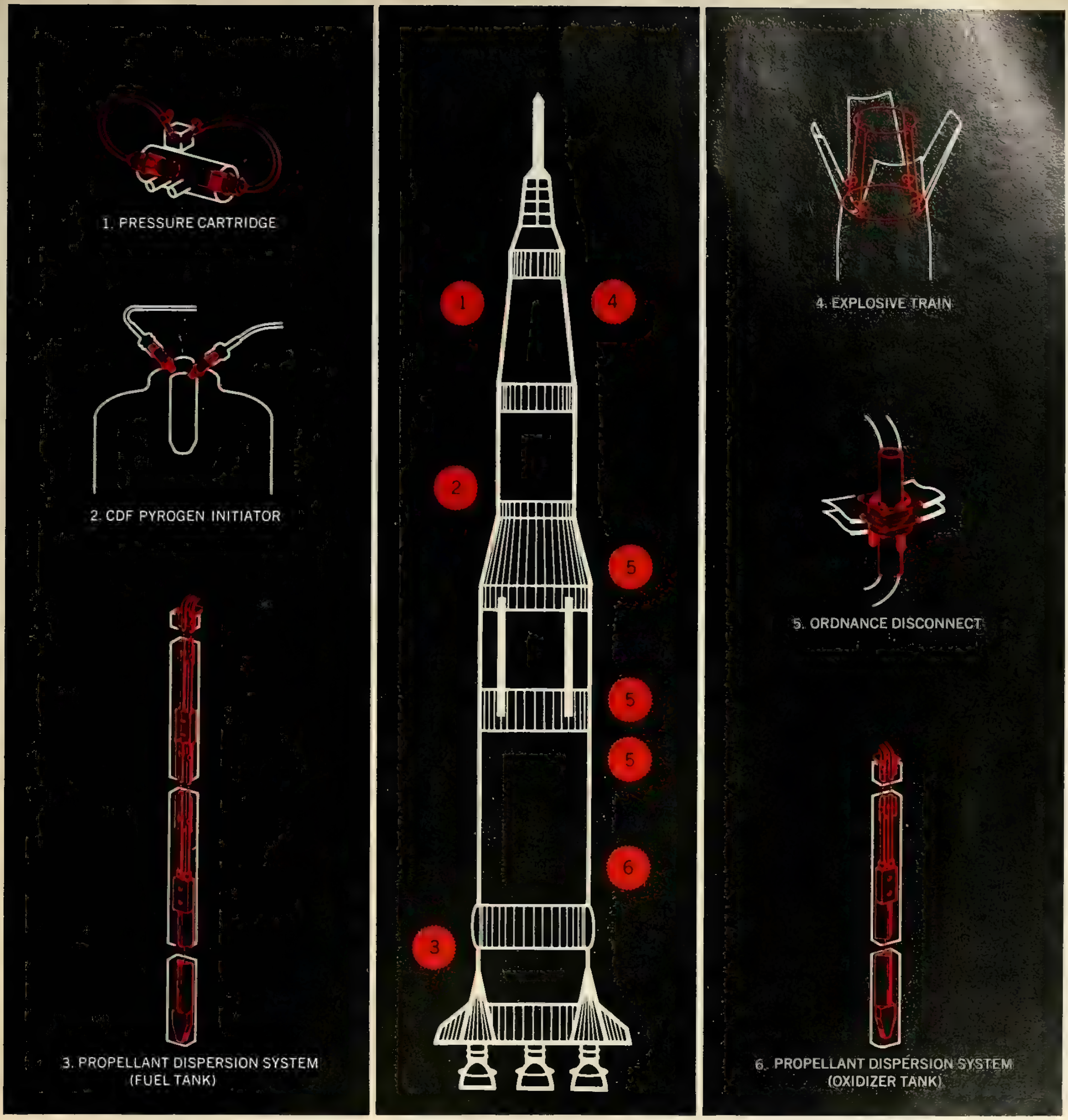

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Designed and manufactured under prime contract to Caltech's Jet Propulsion Laboratory, the Mariner IV video storage tape recorder is one of many unique Raymond recording instruments. It encompasses playback at previously unheard of speed of .01" per second which required development of extremely low noise level amplifier for satisfactory signal-to-noise level. A servo system and buffer storage provide jitter free reproduction in synchronization with the spacecraft clock.

The proven performance and reliability of earlier spacecraft recorders had an important bearing on Raymond's selection to build the vital video storage recorder/reproducer for Mariner IV as well as Mariners A and B. On Tiros VII, launched over two years ago, a Raymond recorder is still performing satisfactorily, having recorded for over 20,000 hours with more than 5,000 playbacks of weather information.

Raymond has long been intimately associated with tape recording in spacecraft. Other space vehicles utilizing Raymond transports include the gamma-ray satellite, all generations of OSO, Nimbus and UK-1. Raymond experience goes beyond spacecraft applications to miniaturized record/reproduce systems such as computer-adjunct aircraft and rocket recorders. Raymond welcomes the opportunity to discuss your precision recorder requirements. RAYMOND ENGINEERING LABORATORY, INC., Middletown, Connecticut.

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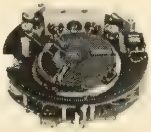
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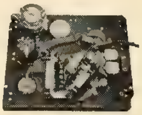
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Write for comprehensive literature on Raymond magnetic tape recorder/reproducers.

Raymond

CAPABILITY
RELIABILITY

into a single motor where they are fired individually. In this case, a single firing chamber and nozzle is used.

The inventors of the first unit described are Eugene E. Elzufon and William Tate, both of ARC. The second patent was issued to Tate, Joseph Padgett, Howard H. Niederman, all of ARC, and Charles K. Leeper, now with Aerojet-General Corp.

Diamant Launch Scheduled

A full scale, three-stage *Diamant* with the *A-1* test satellite was scheduled to be launched late last week by France's SEREB (Société pour l'Etude et la Réalisation d'Engins Balistiques).

The *Diamant* has a liquid first stage and solid upper stages with a rated ability to put an 80-kg. payload into 400 to 1,200-km orbits or 20-kg payloads in a 10,000-km eccentric orbit.

The *Diamant* launch vehicle was developed in a building block approach with the *Topaze* and *Rubis* rocket programs furnishing the second and third stages. The *A-1* satellite has been successful in six previous launches and is designed to check out the ability of the *Diamant* launch vehicle.

British Polaris Tubes Arrive

The first shipment of a total of 64 *Polaris* missile launchers to be used on British ballistic-missile submarines has arrived in England.

Westinghouse Electric Corp. has delivered 16 completed launching tubes to Vickers-Armstrongs (Shipbuilders), Inc., Lancashire, England, for installation aboard a British nuclear-powered submarine.

The delivery is part of an U.S.-United Kingdom agreement signed in April 1963. Westinghouse earlier delivered a training launcher to the Royal Navy *Polaris* school crew-training facility in Scotland.

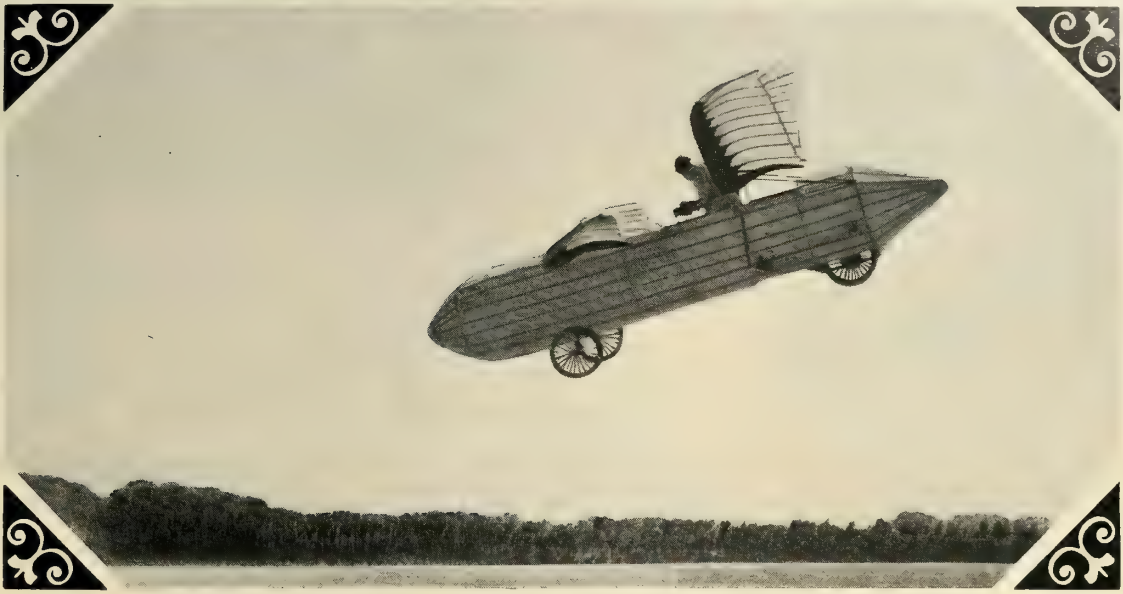
Apollo 009 Static-Fired

Despite curtailments caused by a failure in the master countdown clock at Cape Kennedy, the first tethered test firing of the *Apollo 009* Service Module propulsion system Nov. 19 was termed a success by the space agency.

Instead of the two 15-minute firings two hours apart planned for the test, the system was fired only once for a total of 20 minutes. Also not tested as intended in the firing was the system's gimbaling apparatus.

Blamed for the test shortcomings

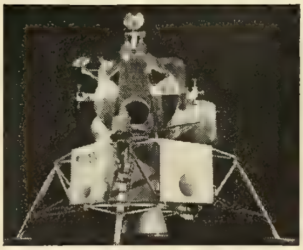
THOSE MAGNIFICENT MEN IN THEIR FLYING MACHINES



"PASSAT ORNITHOPTER" From the 20th Century-Fox motion picture "Those Magnificent Men in their Flying Machines".

...Four Point Landing

Created in 1910, the Passat Ornithopter was the first flapping wing air machine ever to fly. The wings flapped through a simple chain-driven reduction gear and cranks. It had great difficulty landing. The last report of this daring contraption was in 1912 when it came to rest in a tree.



Another difficult landing is anticipated in the late sixties when the LEM (Lunar Excursion Module) now being built by Grumman for NASA will separate from the Apollo Command Module and begin its descent to the lunar surface. How do you land a space vehicle on the moon when the characteristics of the surface are unknown? The four-leg LEM is designed so that its landing gear can withstand a number of arbitrary conditions . . . including complex combinations of vertical & horizontal velocities, vehicle attitudes, surface slopes, friction coefficients and pot holes.

Landing the "Magnificent Men" of our generation – the Astronauts – on the moon is considered by many to be the greatest technical endeavor of the times. Engineers and scientists who can contribute to this and other advanced programs are urged to explore the following immediate positions:

Space Dynamicists—BS or MS in Physics, Aerospace Engineering, Applied Math or Applied Mechanics, with a minimum of 2 years experience in the analysis of flight dynamics. Experience in space dynamics, e.g. disturbance torques, orbital mechanics, lunar trajectory analysis, and separation system dynamics is desirable.

Guidance Dynamicists—BS or MS in AE, EE, or Applied Mechanics with a minimum of 2 years experience in the analysis of guidance systems for spacecraft. To analyze and evaluate functional configurations and dynamic characteristics of radar, IR, optical and inertial guidance loops; signal processing and error analysis. Background in sampled data & nonlinear controls systems.

Guidance & Control Integration Engineers—BS or advanced degree with experience in design, analysis and integration of vehicle guidance & control systems. Applicants should possess a working knowledge of both analog & digital feedback system & design techniques. System test or hardware design experience desirable. Position entails conceptual work in defining guidance & control systems, establishing subsystem and component requirements, system development and verification.

Control Dynamicists—BS or MS in AE, EE or ME with a minimum of 2 years experience in analysis of control systems. Will evaluate automatic flight control system stability and performance. Familiarity with nonlinear techniques, digital control techniques is desirable.

Systems Engineers—Facility and Services—BS or advanced degree with a minimum of 2 years experience in establishing the requirements for facilities and the criteria for the evaluation of existing facilities. Applicants will be required to survey tests and operational sites both ashore and afloat to verify weapon system compatibility with existing facilities and support equipment. Ability to recommend and/or originate solutions to preclude potential interface difficulties is necessary. Recent military experience and/or good working knowledge of military organization desirable.

Additional opportunities on following page

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(Continued from previous page)

Mission Analysis Engineers—Plan LEM missions and determine related spacecraft functional requirements. Normal and emergency operations during both development and lunar landing missions are to be considered. The work will involve contact with engineering and test sections at all levels. A minimum of 5 years experience, preferably in systems analysis, preliminary design or operation analysis is required.

Human Factors Engineers—MA or PhD in Experimental Psychology with 2 years Human Factors experience: BS in Engineering with appropriate experience will be considered. Positions are available in Systems Analysis, Display and Control Design, Work Station Layout, Design for Maintainability, Training Requirements, Training Devices and Experimental Studies.

Systems Co-ordination Engineers—will coordinate a program that organizes, validates and controls the overall functional requirements of an advanced manned spacecraft project fulfilling project objective as prescribed by the procuring agency. These functional requirements are translated into over-all vehicle performance and design requirements, establishing systems parameters from which the vehicle, its major subsystems, and support equipment are designed. Task assignments include: internal and external liaison with design specialists & systems personnel & direction of the incorporation of established requirements into top systems and vehicle specifications. Applicants should possess a BS or MS in ME, EE or Physics and a minimum of 3 years of systems analysis or integration experience in a major systems effort.

Environmental Vibration Engineers—B.S. degree with a minimum of 5 years related experience in the prediction of vibration & shock environments, translation into specifications & verification of design adequacy by analytical & experimental means. Familiarity with techniques & equipment for sinusoidal & random vibration test & analysis is required, as is experience in specification interpretation. Moderate travel for vendor & customer contact necessary.

Radar Development Engineers — BSEE with a minimum of 4 years experience in the analysis, design and development of airborne radar systems. Should be capable of analyzing the radar system with end view of integrating the equipment into a complex space vehicle system. Will fully participate in laboratory and flight development program conducted in the finest facilities available in a professional atmosphere.

EMC Systems Engineers—With ability to perform system analysis, state-of-the-art reviews, and develop advanced EMC techniques. Will be responsible for generating design data, control plans, test plans, directing tests, analyzing results, generating fixes, and preparing reports for systems in accordance with MIL-E-6051C. Familiarity with WR-27 and MIL-STD-449 is essential.

Communications Systems & Equipment Engineers—BSEE with a minimum of 2 years experience in Communication and Radio Navigation Hardware Engineering. Familiarization with the following equipments is desirable: H.F. (SSB), VHF/FM & AM, UHF/FM & AM, Voice & Data Link Communications Equipment, ADF, VOR, TACAN, Radar Altimeter, and Doppler Navigation. Duties include: Systems integration, analysis of equipment design, circuit & component analysis, generation of equipment specifications, information and test procedures information, liaison with subcontractors & contractors; laboratory & vehicle system testing.

Aircraft Navigations Systems Engineers—BSEE with a major in control theory and 3-8 years experience with small analog computers, inertial sensors and solid-state circuit design. Knowledge of aircraft navigation systems, required; capable of designing small analog computer and investigating total navigation system problems.

Inertial Navigation Systems Engineers—BSEE (MSEE preferred) with major in control theory and 3-8 years experience in the design & development of navigation systems hardware. Should be capable of directing major systems redesign program. Circuit design experience desirable but not essential.

Vendor Liaison Engineers—Space Guidance & Control Systems—BSEE with major in control systems with 3-5 years experience in Guidance and Control, Design and Development. Will conduct technical liaison with vendors to assure compatibility between hardware and specifications, and be responsible for technical interface control.

Computer System Engineers—Engineers & Mathematicians with 1-5 years experience in the analysis, design and development of digital computer systems.

Programmers—Experienced in both general purpose and special purpose techniques, to work on complex systems for aerospace vehicles.

Liaison Systems Test Engineers—BS in EE or Physics plus 4 or more years of relevant systems test experience. Will perform early test planning, evaluation testing & debugging of new systems in addition to performing any sustaining engineering support required during subsequent program phases. Assignments involve hands-on trouble shooting & remedial design requiring exceptional technical proficiency.

Use the attached inquiry form to arrange a mutually convenient interview.

Ideal for mounting, an 8 x 10 color photograph of the pioneer aeroplane on previous page is available free, at no obligation, to qualified engineers and scientists (who identify themselves as such). Write address as shown in inquiry form.

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PROFESSIONAL PLACEMENT INQUIRY

For your convenience and to facilitate your inquiry, please use this form. It will enable the professional staff at Grumman Aircraft to evaluate your background and experience and arrange for a mutually convenient personal interview. All inquiries will be held in strictest confidence. Enclose in an envelope and send to Mr. P. M. Van Putten, Manager, Engineering Employment, Dept. GR 86, Grumman Aircraft Engineering Corp., Bethpage, L.I., N.Y.

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CITY & STATE________TELEPHONE________

NEAREST MAJOR CITY (IF APPLICABLE)________________

COLLEGE GRADUATE: YES___NO___

Degree	Subject	Year

Major Specialty________Yrs.____Other Specialty________Yrs.____

Applying for position(in)(of)________________

Background and experience (Brief resume of experience, recent history of employment. If available, attach prepared resume.)

was the countdown clock, which only a split second after ignition recycled to T minus 99 seconds, throwing the count out of real-time. The ground computer, part of the acceptance checkout equipment that operates in plus-time only, was thus unable to send the signal to gimbal the engine. For the same reason, the ground computer was unable to send the signal to shut off the engine at the 15-minute mark, and a signal from the blockhouse had to be substituted.

Iodine Lubricates Metals

A class of iodine complexes, identified by General Electric scientists as having the ability to lubricate the wear surfaces of titanium and stainless steel, should increase the applications of both metals.

The iodine additives will contribute heavily to the machining, rolling and polishing of metal stock as well as in final end-use applications. The GE experts believe the activated iodine in the lubricant reacts instantly with fresh surfaces of titanium, iron and other metals to form a thin protective film. The film contains a lamellar diiodide with a crystal structure similar to graphite. A patent has been issued to GE employees for the family of lubricants still in research at the firm's Research and Development Center, Schenectady, N.Y.

Four Picked for Apollo 'Pallet'

NASA has selected four companies for four-month design studies on an experiments pallet to fly aboard Project *Apollo* missions.

They are Lockheed Missile and Space Co., McDonnell Aircraft Corp., Martin Co., and Northrop Space Laboratories.

The firms, under separate fixed-price contracts valued at approximately $375,000, will design, develop detailed specifications, and produce mock-ups of a pallet to be placed in the *Apollo* spacecraft Service Module.

The pallet will house scientific, experiments to be carried on *Apollo* missions of up to two weeks' duration beginning in 1968.

After review and evaluation of the design studies, NASA plans to select one of the firms to develop the experiments pallet flight hardware under a cost-plus-incentive-fee contract.

The pallet will occupy one of the six pie-shaped segments in the Service Module. It will be 146 in. high, 50 in. deep and 63 in. wide on the outer surface. Total volume is 170 cu. ft. Other segments of the Service Module contain fuel tanks and electrical, environmental and propulsion systems.

Space in the pallet will be arranged in shelved compartments for installation of the instrumentation required for specific experiments. Some of the experiments being studied for *Apollo* flights will require astronauts to retrieve instrumentation from the pallet and place it aboard the Command Module for return to Earth. Other experiments will transmit data to Earth during the mission and will be left in the pallet.

The four firms selected were among nine which responded to a request for proposals issued by the Manned Spacecraft Center, in September, 1965.

AF Accepts AMU Delivery

A self-propelled back-pack, designed for astronaut extravehicular activity without use of a tether, has been delivered to the Air Force Space Systems Div.

The Astronaut Maneuvering Unit, developed by LTV Aerospace Corp., is scheduled for use in Air Force experiments on *Gemini 9* and *Gemini 12* flights. The unit is designed to allow an astronaut in a pressure suit to operate much like a one-man space vehicle, independent of his spacecraft. During experiments on the *Gemini* flights, however, a tether will be used, along with a smaller chest pack, the Modular Maneuvering Unit, developed by NASA.

The AMU is propelled and controlled in attitude by 12 hydrogen peroxide-powered jets located at the corners of the pack. They are used in various combinations for maneuvering or changes of direction.

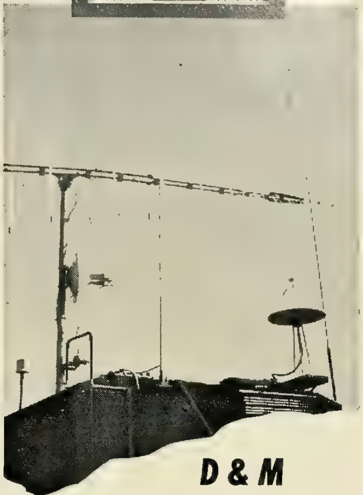
Parker Elected by AIA

J. S. Parker, vice president and group executive, Aerospace and Defense Group, General Electric Co., has been elected chairman of the board of directors of the Aerospace Industries Assn. at the association's fall meeting in Phoenix, Ariz.

Courtlandt S. Gross, chairman, Lockheed Aircraft Corp., was elected vice chairman at last week's meeting.

Parker, who served as vice chairman this year, will succeed J. L. Atwood, president of North American Aviation, Inc., on Jan. 1.

Karl J. Harr, Jr., was re-elected president of the association. V. J. Adduci was re-elected vice chairman and Samuel L. Wright was re-elected secretary-treasurer.



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- ☐ Build a nerve center for Saturn launch vehicles
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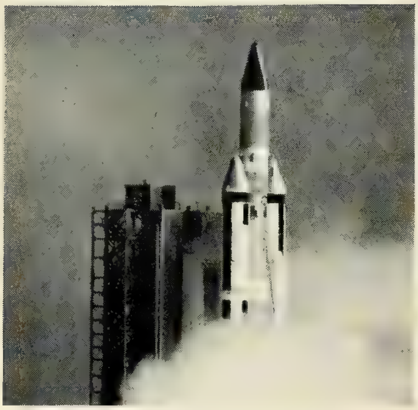
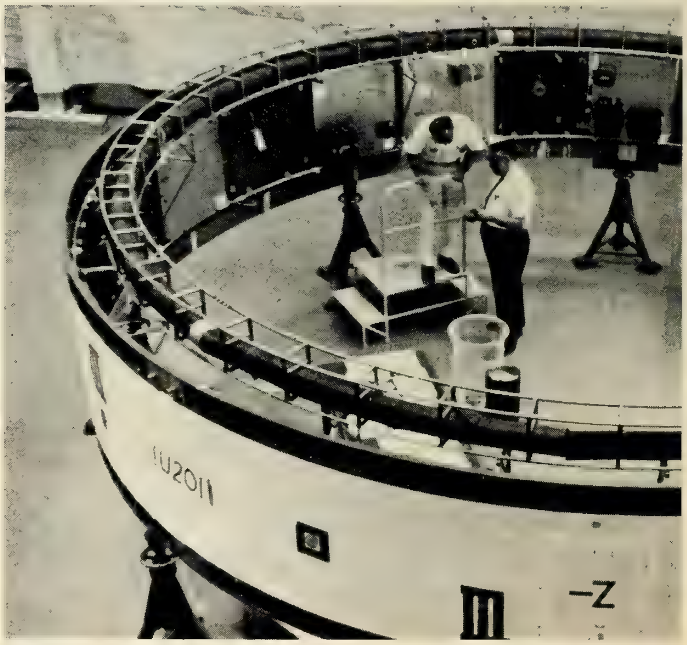


Steering Titan launch vehicles from pad to orbit. ☐ This is the job for a compact, rugged IBM computer, a key element of the Titan III guidance system. It's from a line of IBM ASC-15 guidance computers that have flown more than 50 successful missions aboard Saturn I, Titan II and Titan III-A. ☐ Before a mission, IBM's computer checks instruments and controls. During flight, the rugged computer generates signals to correct roll, pitch and yaw to keep the vehicle on course. ☐ This IBM computer withstands the thrust of rocket blast-off and temperature extremes. And its record proves that it's tough, reliable and accurate.



Building a nerve center for Saturn launch vehicles. ☐ Since April, 1964, IBM has been lead contractor for this part of NASA's Saturn launch vehicle program. This is a management assignment to construct Instrument Units for Saturn 1B and Saturn V which are being developed under the direction of the Marshall Space Flight Center. ☐ The Instrument Unit is Saturn's control center. Located between the Apollo spacecraft and the upper stage of a Saturn vehicle, it controls and guides Saturn's first, second and third stages before releasing Apollo for its lunar flight. ☐ IBM's job includes designing and manufacturing data adapters and computers for the Instrument Unit, plus total systems integration and checkout of the more than 50 electronic units that make up the Saturn launch vehicle.

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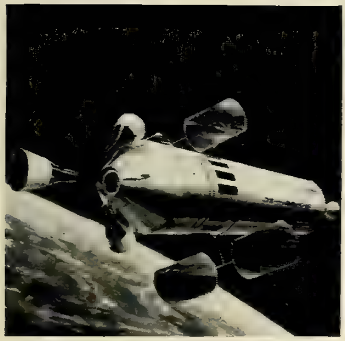
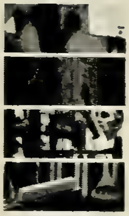


Solving down-to-earth problems from space. ☐ Orbiting space stations 200 miles high will provide a new point of view for the study of earth resources, weather patterns and crop yield. With this information, scientists will be able to recommend action to avert famine, flood and disease. ☐ IBM's job is to define these space station experiments for NASA. IBM simulation labs are developing new techniques to be used in surveying the earth from orbiting spacecraft. And IBM scientists are presently studying the problems and recommending the best sequence of experiments for space flights of the future.

Memorizing all the Gemini flight plan alternatives. A massive assignment. However, at NASA's manned spacecraft center in Houston, Texas, 5 powerful IBM 7094-II's—along with one of the world's largest memories, the IBM 2361 Model II Direct Access Core Storage Unit—can accomplish this and much more. As fast as far flung outposts across the world transmit their real-time in-flight data on each Gemini flight, IBM computers are analyzing the data . . . storing it . . . forwarding it to the NASA flight controllers for decision . . . and building the increasing store of facts and data so necessary for the first flight of American astronauts to the moon.



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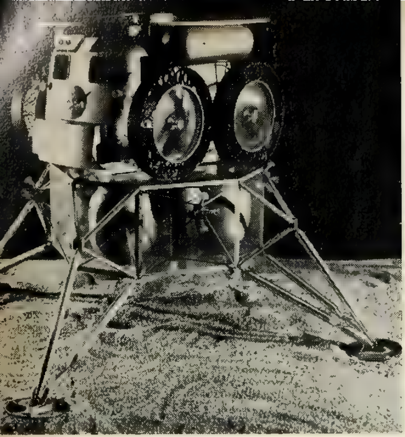

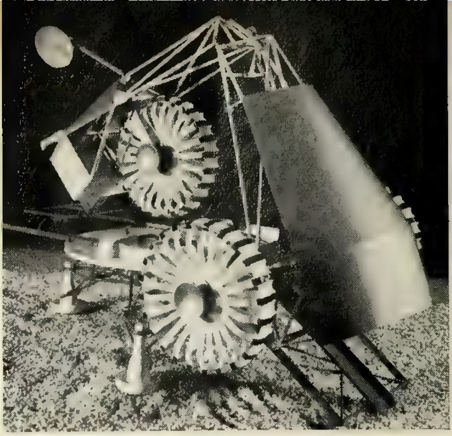

Designing a mobile lunar laboratory is one thing.

Deploying one on the moon's surface is another.

Integrating man and mission is still another.

Bendix is doing all three, and more.

Meeting the many lunar surface exploration problems head-on is a major effort of the Bendix Corporation. Our leadership in technology won us a National Aeronautics and Space Administration contract to design the first U. S. mobile lunar laboratory.

Our lunar surface exploration activities include determining how to get such vehicles off soft landers and right down to business on the moon's surface.

Still other contract tasks include developing sample scientific experiments and missions U. S. astronaut-scientists will perform while on their history-making, 14-day geological expedition across the lunar surface.

These Bendix activities, and more, are covering all fronts of lunar surface exploration. Our unique combination of experience in automotive, aerospace and electronics provides continuing support to the leadership in space exploration at NASA.

Bendix Systems Division THE Bendix CORPORATION

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TRW PHOTO BY ROBERT W. YOUNG

Thrust-Augmented Thor-Agena D launches OGO II from Vandenberg AFB.

THE YEARS BEYOND

Even as the Apollo manned lunar landing program moves from production line to launch pad, the National Aeronautics and Space Administration is beginning its reach toward even more distant goals in space. For the first time in four years, the forthcoming NASA budget will carry substantial funding for new projects. This fifth annual NASA issue takes a look at the plans and programs which will carry U.S. space exploration into the 1970s.

Dynatronics again meets the challenge

Deliveries of the PCM Data Complexes for Apollo are now being made to NASA/Goddard.

The Dynatronics designed systems offer the capability of complete computer control and the ability to handle formats in number and complexity heretofore unobtainable. In addition unique self-check features allow complete evaluation of the entire system as well as individual subsystems.

The Universal Concept was followed by Dynatronics in the solution of Apollo PCM requirements.

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WEBB: U.S. SPACE TEAMWORK COMES OF AGE

MAJOR ACCOMPLISHMENTS have marked the year since the last previous annual MISSILES AND ROCKETS issue devoted to NASA.

Project *Gemini* has demonstrated the kind of significant advance it was designed for. Extravehicular activity and man's ability to adjust to the environmental differences of space and function effectively for a period equivalent to that required for a lunar journey were demonstrated.

While major attention was focused on the *Gemini* missions, the *Apollo* project was progressing. The *Saturn I* program was completed with ten successful flights. *Saturn IB* is nearing its first flight. All *Saturn V* engines have proved successful in ground tests.

In three successful flights, *Ranger* returned more than 17,000 useful pictures of the Moon.

Mariner IV returned the first closeup pictures of Mars. *Pegasus* returned data on the number and size of micrometeoroids in space. Other scientific satellites such as *Explorers* and the *Orbiting Solar Observatory* enabled us to increase our knowledge about the Sun and planets, our own Earth, and space itself.

In the field of applications satellites, NASA's *Tiros X* became the first operational weather satellite, and the Communications Satellite Corporation's *Early Bird* was launched as the first commercial communications satellite.

Perhaps the most important thing that should be pointed up in reviewing the year just past, however, is that *Gemini, Ranger, Mariner,* and all of the others demonstrate how far our space team, with American industry working in partnership with Government agencies and the universities, has pushed forward in developing science and technology.

About 90 percent of NASA's budget goes out under contract to American industry—to pay for work by almost 400,000 men and women in the factories and laboratories of 20,000 prime and subcontractors. Working on space-related projects on the campuses of more than 100 universities in every state of our union are almost 10,000 scholars, researchers, students, and those in technical vocations related to research and education.

To support its missions and contractors, NASA has established an information system to give immediate access to the world's aerospace and technical literature. This presently includes over 200,000 unclassified technical documents and reports, which are abstracted, indexed and filed in a computer-based system, to permit rapid matching of technical information to specific problems and objectives.

This is just one facet of the interlocking relationships that have brought success. Our success in space is clearly the product of a remarkable blend of economic research and political institutions.

Like all partnerships, however, it has problems and frictions that reduce its effectiveness.

Significant influences of recent years which have been pointed out in many studies include:

—The demand on industry for faster rates of technical advance;

—The increased complexity and technical difficulty of major programs, with consequent delays and cost overruns;

—The decreasing volume of production work and increasing volume of research and development contracts;

—The steady increase in the requirement for technical and program management personnel;

—The requirement for Government to better define its objectives and requirements;

—The emphasis in the procuring agencies on increasing competition at all stages, including research and development;

—The changes in contracting methods which offer more incentives but impose more risk on contractors;

—The necessary increases in Government controls on configuration, on quality, and on financial data in multiple-contract large and long-lead-time projects.

The results of these influences have been many. Certainly, the trend to incentive contracting is consistent with the Government's desire to withdraw from all but essential participation in the solution of contractor management problems. I believe Government and industry must increase their efforts to find better ways to work together.

For their part, contractors must achieve more effective internal program controls, better forecasting, and quicker reaction time in problem situations. In awarding new business, procuring agencies must judge contractors on measurable results, as well as take into account a contractor's prior management performance.

Only by keeping our industry and Government management capability in step with our racing technology can we achieve the full benefits from our industrial base.

James E. Webb

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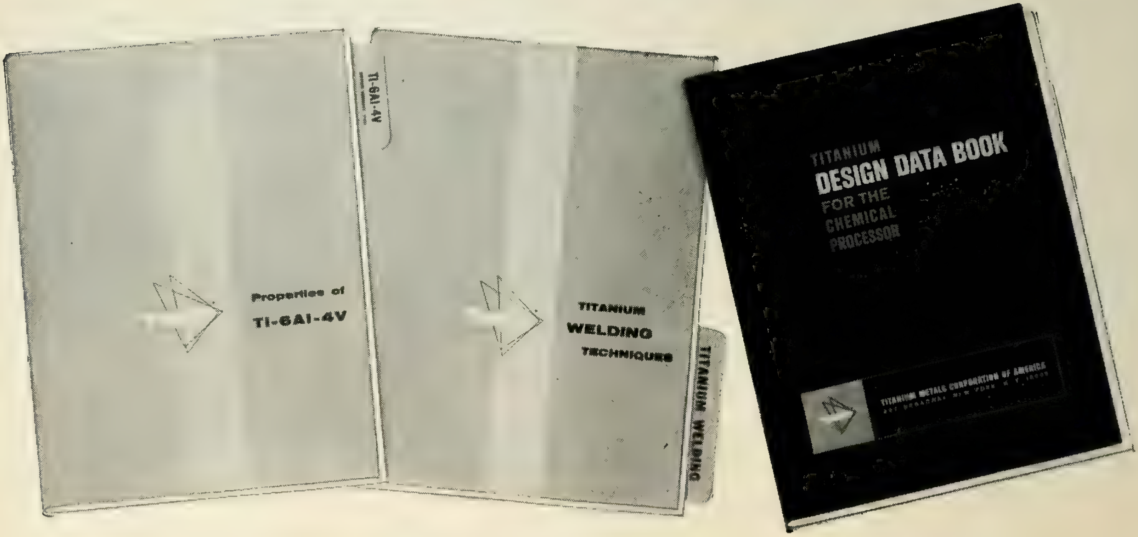

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PART I

BUDGETS

Agency Pressed to Hold Spending Level

NASA wants $5.6 billion for FY 1967, but Administration says outlay should be held to present $5.26 billion; little change expected

NASA is still hoping for a Fiscal Year 1967 budget of $5.6 billion, but Johnson Administration officials have asked the agency to keep it at the same level as the FY '66 request of $5.26 billion.

There have also been unconfirmed reports that a cut to $5 billion or below is in the offing, but Administration officials say this is highly unlikely.

One such official told MISSILES AND ROCKETS that the best bet is that the new space agency budget will be very close to this year's. He added that if there is an increase it will be a small one.

While far below what NASA believes is needed for balanced, well-paced program, the $5.25-5.26 billion level will permit fairly sizable hardware development starts for both of the agency's high-priority projects—*Voyager* and *Apollo* Applications.

It does reflect, however, the disagreement between NASA and Bureau of the Budget over the kind of long-term funding needed to take advantage of the space capability developed for Project *Apollo* in order to accomplish even greater space feats in the future.

The NASA position is that despite the fact that *Apollo* funding in FY '67 is still at its peak level, with no decline expected until 1968, the overall budget should be increased so that substantial starts can be made on projects it wants to fly late in this decade and early in the 1970's.

The same increase, if the NASA position were approved, would continue for the next three or four fiscal periods before reaching a plateau where it would remain for several years.

Under the NASA plan, if the level of $5.6 billion for FY '67 were approved, the budget would rise to $6 billion in FY '69 and '70. The Administration position is that increases should be deferred until *Apollo* funding tails off, now expected to be FY '68. And while they would permit an increase in that year, it would not be as big as the space agency would like—nor would the increase in later years be as high as the agency desires.

The final outcome will probably not be known until late December or perhaps January.

While *Voyager* and *Apollo* Applications can be initiated with a $5.26-billion budget, the expected start on nuclear propulsion, unmanned planetary exploration and manned space stations which would have been funded late in this decade probably would have to be delayed longer.

And while significant *Voyager* and *Apollo* Applications programs can be initiated, they will not be going at as fast a rate as NASA officials feel is necessary to take advantage of the programs' full potential.

• **FY '67 breakdown**—Next year's budget—if it is near the $5.26-billion mark—will mean that Manned Space Flight program funding will rise slightly, to just over $3.6 billion. The Office of Space Sciences and Applications funding level will be approximately $900 million, the Office of Advanced Research and Technology will be around the $400-million mark and the Office of Tracking and Data Acquisition will receive about $300 million.

Within the Office of Manned Space Flight, the cost of Project *Apollo* is expected to continue at about the same rate as it has this year, but a sharp reduction in *Gemini* program funding will be possible because that two-man

NEW U.S. SPACE PROGRAMS AT A GLANCE

APOLLO APPLICATIONS	Funding level in FY '67 expected to be about $200 million. If NASA budget is cut to $5 billion, program will be delayed one year.
VOYAGER	Funding level of at least $150 million is almost certain.
MANNED SPACE STATIONS	Main field-center responsibility to be shifted from Langley Research Center to Manned Spacecraft Center. Large ($1-million) study contract for artificial-gravity stations to be awarded.
ADVANCED MANNED MISSIONS	Direct ascent now favored as method of building a lunar base. Decision on manned Mars mission off for two or three years.
ADVANCED UNMANNED MISSIONS	Extended Pioneer expected to be funded in FY '67. Venus mission with Voyager-type spacecraft planned for 1972-74.
EARTH SATELLITES	Scientific satellite program expected to continue at about present funding level. Any major change in program will depend on decisions yet to be made on Apollo Applications and other manned space programs. Explorer and Observatory series expected to continue through the 1970's.

program will be reaching its conclusion.

Research and development funds for *Apollo* will drop perhaps only $2 million from this year's level of $2.9 billion. Included will be $1.2 billion for the spacecraft, compared to $1.1 billion this year.

Funding of the *Saturn V* booster will also remain essentially at this year's level of $1.2 billion.

Money for the *Saturn IB* launch vehicle—with its first launch scheduled in January—will decrease from $250 million to $200 million as its development curve begins the downward swing. There will be no funding for the *Saturn I* program, which is now completed.

The drop in R&D funding for liquid-propulsion engines in the program reflects the R&D curve for *Apollo*, which is now reaching the point where the concentration is on development of major systems rather than subsystems. Funding for the liquid-hydrogen J-2 engine and the liquid oxygen/kerosene F-1 engine will drop from $150 million to about $100 million.

One area in Manned Space Flight which will receive major increase is launch operations, mission, control and launch support services. This is caused primarily by the large increase in the number of manned flights to be launched as the first Earth-orbital Project *Apollo* flights are made. Estimated increase is from $100 million this year to $150 million next year.

Construction of facilities will also increase next year, from $23 million to a little over $50 million. Primary cause for the increase is that no funds were requested in the FY '66 budget for Launch Complex 39 at Cape Kennedy, but funds will be needed next year to complete the two launch pads from which the *Apollo-Saturn V* flights will be made.

In other R&D programs, funding for advanced mission studies will remain at the $10-million level, and supporting development funding again is expected to be about $25 million.

The reduction in *Gemini* budget is spread throughout the program. Development of the spacecraft is dropping from $125 million this year to only about $20 million next year. The *Titan II* and *Atlas-Agena* launch vehicles in the program will be cut from $90 million to about $10 million.

Also, mission support activities, which are budgeted for $30 million this year will drop to only $10 million next year.

- **Overall budget**—In predicting a NASA budget of $5 billion or less, a few pessimistic Washington observers believe that the high cost of the war in Viet Nam and the resulting large increase in DOD's budget next year will mean that the budgets of other Government agencies will have to be reduced.

Administration officials note, however, that the Gross National Product is rising at a rate of 4-5%, and this, coupled with increased spending because of last year's tax cut, will provide a large increase in Federal Government tax earnings in the next fical year.

The increased Government earnings, as well as cost-cutting programs within DOD, should offset most of the increase in the defense budget.

A NASA official told M/R that the agency has not been asked by the budget bureau to reduce next year's request below the amount in the current year. He said the only guideline issued thus far is that the request should be kept close to this year's level.

A high-ranking Administration official also said he knew nothing of plans to cut the agency budget to $5 billion or below. He said that the most likely level is at about this year's total—and that a small increase is a possibility.

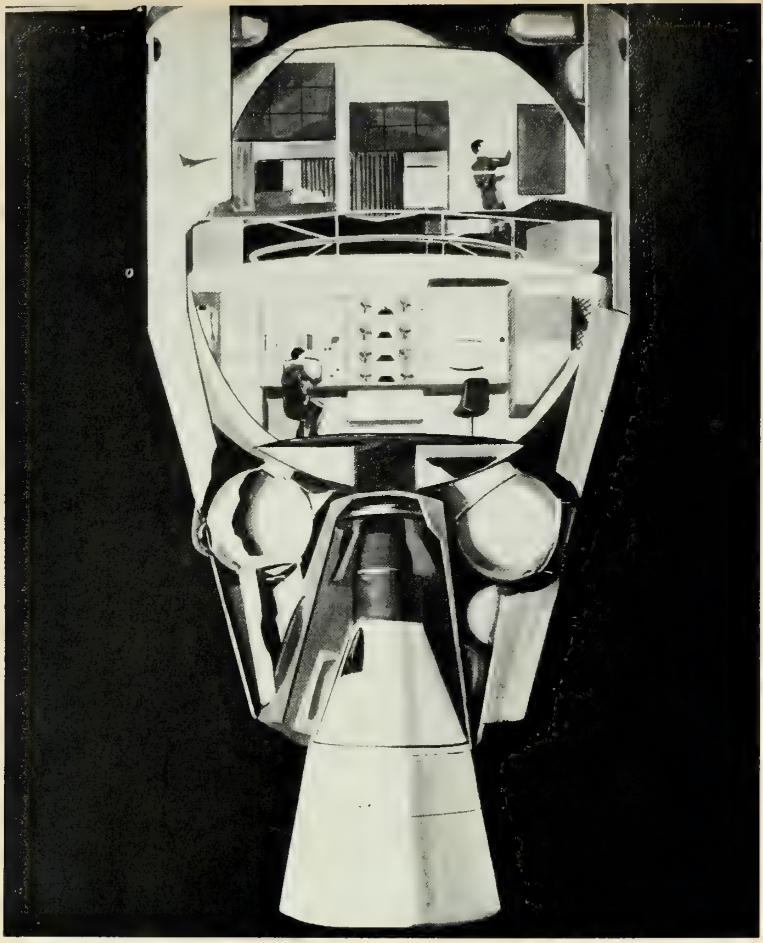
Members of the House and Senate Space Committees also expressed serious doubts about the possibility of a $5-billion-or-below budget. Rep. George Miller (D-Calif.), chairman of the House group, told M/R that he did not believe NASA could accomplish its goal of landing a man on the Moon by the end of this decade, as well as making an orderly start on the new programs which Congress has already approved, unless the budget is at least $5.26 billion.

- **Apollo Applications**—The one program which probably would be severely affected by a reduction in the NASA budget is the three-man *Apollo* Applications manned spaceflight program. Space agency officials had hoped to begin the program next year with a budget of over $400 million.

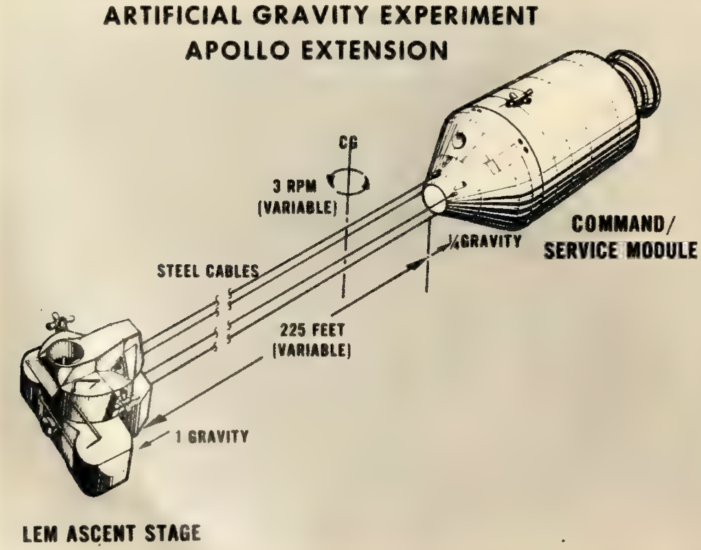
Such a comparatively high level is very unlikely at this point, and it is believed that if a $5.26-billion request is approved, the AA funding will be about $200 million.

That level of funding will permit NASA to begin hardware funding of the six or seven 14-day flights which will

SPACE BOOSTERS	High-energy planetary kick stage may get hardware funding in FY '68.
ADVANCED APPLICATIONS TECHNOLOGY SATELLITES	Report on possible navigation satellite expected before end of year.
INTERNATIONAL PROGRAMS	ESRO may buy U.S. booster. Other new agreements in the offing.
OART PROGRAMS	Delta-wing X-15, ramjet engine to be funded in FY '67. Orbital Scanner satellite approval expected.
NUCLEAR SPACE POWER	Nuclear rocket stage will not be funded until FY '68. Power units for lunar experimental package and Voyager under design.
COMMUNICATIONS SATELLITES	Contracts expected next spring on Comsat Corp.'s advanced global satellite system. Funding under way on the NASA/Comsat satellite system for manned space program and commercial uses.



ARTIST'S CONCEPTION of Manned Orbiting Research Laboratory configuration which may eventually become NASA's first true manned space station.



be made with unmodified *Apollo* spacecraft beginning in 1968. Funding of experiments and long-lead-time items for longer-duration missions could also start next year. *Apollo* Applications at this point is conceived as a four-year program ending in 1971. Scheduling of the early missions, however, depends on the success of the *Apollo* program and whether any spacecraft will be available for use in *Apollo* Application missions.

Thus, slippage into 1969 for the first flights is a definite possibility. Ultimately, this could mean the program would end in the 1972-73 period.

The program which NASA would like to approve calls for a total of 25 flights. In addition to the 14-day missions, there would be eight 45-day long-duration missions including one synchronous-orbit flight with the primary goal of making astronomical observations.

Nine flights for either 14-day lunar surface-exploration staytime missions or 28-day lunar-orbital flights are also scheduled.

One highlight of the AA program will be a series of three consecutive rendezvous-and-docking missions toward the close of the Earth-orbital flight series.

Earth-orbit flight no. 10 with the primary mission of putting an astronomy/bioscience laboratory into orbit will also rendezvous with Earth-orbit no. 11 spacecraft which also has a primary mission of putting another astronomy/bioscience laboratory into orbit. The two spacecraft will then attempt to stay in orbit for beyond 45 days.

Earth-orbit flight 12 will then rendezvous and dock with E 11, with the goal of extending the total three-rendezvous mission duration to 135 days in orbit.

Total estimated cost of *Apollo* Applications is at least $6 billion, with well over one billion dollars being committed to funding of experimental payloads.

- **Voyager**—The funding level for this unmanned spacecraft, which will explore Mars in 1971 and 1973, is expected to be about $150 million in FY '67. The funding will be used primarily to pay for the spacecraft bus and the systems definition phase for the capsule which will land on the Martian surface in 1973.

NASA officials report that $150 million is expected to be the average expenditure per year if the 7-year program costs the total $1.3 billion estimated.

Plans for post-1973 launches are already being made, and it is expected that those missions will receive their first funding in the Fiscal 1969-70 period. ■

Total Buying Jumped 13% in FY '65

First disclosure of increase is coupled with report of rise in incentive contracting; changes made in R&D, contract controls

NASA HAS DISCLOSED for the first time that its total procurement expenditure in Fiscal Year 1965 was 13% greater than the outlay in FY '64. This, together with an investment in incentive contracting estimated to be three times that of a year ago, indicates the direction of space agency procurement actions in the year ahead.

A full report on FY '65 procurement is expected on Dec. 13.

At the same time, NASA and the Dept. of Defense have completed organization of a cooperative contract-administration system and the space agency has officially issued a four-part management plan for better control of its large research and development contracts. Both actions are expected to make space agency procurement more effective and better-controlled as NASA efforts move from the Moon into planetary exploration.

NASA's total procurement money for FY '65 increased to $5.187 million. Of that amount, the space agency itself placed 79%. Four percent was contracted out by educational and non-profit organizations, 5% was placed by the California Institute of Technology's Jet Propulsion Laboratory and 12% was spent by other Government agencies.

Figures released by Ernest W. Brackett, NASA assistant deputy associate administrator for procurement policy, showed that 94% of the total FY '65 dollar award went to industry, with North American Aviation, Inc., receiving $1,099,448,000, the top firm. Competitive procurement was also up for the year and average fees on contract work rose to 7.03%. The fee—which includes cost-plus-fixed-fee and cost-plus-incentive-fee awards—was up from 5.99% in FY '64 and 6.65% in FY '61.

● **Subs on rise**—Subcontracting actions also increased in number and distribution during the last fiscal year. Eighty-six prime contractors (each receiving awards totaling $500,000 or more) placed subcontracts with 2,212 companies in 9,575 separate actions. Each firm received $10,000 or more in subcontracting money, for a total of $1.075 billion. The 86 primes, located in 23 states, let subcontracts in 45 states and the District of Columbia. The space agency itself placed prime contracts in every state.

The top 100 contractors for Fiscal '65, led by North American, included 36 companies new to the list. Fourteen of the 100 are designated small business firms. Contract placement with small business was up for FY '65, Brackett told MISSILES AND ROCKETS. Number of awards to small business increased 19% over Fiscal '64; these firms now receive 63% of the total number of awards.

Of the new contracts placed in FY '65, 17% of the dollar value went to small business firms. These companies now receive 7%—or $286 million—of the total money awarded.

When invited to participate in contract competition, Brackett said, small business firms received 49% of the total dollar awards.

● **Incentive gains**—A space agency goal to bring the value of incentive contracts up to $1 billion by the end of Fiscal 1965 has been met with a success of more than 200%.

According to Brackett, the number of incentive contracts reached 136 by the first of October of this year for a total investment of over $2 billion. The drive for greater incentive contracting will continue, the official said.

During August and September of this year, 15 new incentive contracts were placed with industry and an earlier contract for $125 million was converted to an incentive basis.

"We are still trying to place as many of these as we can," Brackett told M/R, "and we are especially trying to negotiate all follow-on awards on an incentive basis."

At this time last year, the space agency had 60 incentive contracts on the books with a total face value of $650 million. That figure had risen from one incentive contract (valued at $100,000) in FY '61; two in FY '62; 17 in FY '63 and 34 at the end of FY '64. By the close of FY '65, 79 incentive awards had been placed with industry.

● **New freedom**—The agency's earlier policy of cost-plus-fixed-fee awards stemmed from the fact that there was little or no precedent for the work being done. The kind of procurement peculiar to NASA—purchase of a few-of-a-kind items—encouraged the earlier reliance on fixed-fee contracting until a history of contractor performance could provide reasonable estimates of cost, delivery and quality of items.

At this point, Brackett said, the space agency still must use many more cost-plus-incentive-fee awards than the fixed-price-incentive contracts. "But we would like to work more and more of them into the fixed-price-incentive area," he said.

Cost-plus-award-fee contracts are now primarily used for programs involving general concepts, Brackett noted. Most of these are service supply awards and result in better performance at less cost for NASA and higher fees for the contractors.

As pointed out earlier, average fees for FY '65 are up to 7.03%, compared to 5.99% in FY '64.

● **New R&D controls**—Detailed implementation of the space agency's new management plan for large R&D programs (M/R, Nov. 15, p. 18) will be outlined in NASA's annual procurement regulations, scheduled for release in the next few months.

The new four-phase policy, announced by NASA earlier this month, will significantly tighten controls over R&D contracting. The plan, which went into effect immediately, is not an entirely new one, Brackett pointed out. However, it does formalize procurement policy for the space agency and "gives management three times to stop and think things over," Brackett said.

Another important feature of the policy is a built-in capability for improved budgeting. Because of the four-part definition of the R&D contract, NASA will have a better basis for estimates of costs and will be able to present more realistic and practical budgets to Congress, Brackett indicated.

The new phase project planning, announced in the recent directive from Administrator James E. Webb, is broken down as follows:

—Phase A—contract feasibility— Under this phase, an unlimited number of corporations would be reviewed for contracting possibilities. Out of these, three or four would probably be chosen for parallel contracts, Brackett explained. They would be asked to analyze

a particular objective or mission in terms of alternate approaches or concepts and review the conduct of that research and technology development requisite to support the initial analysis. The study would also help to determine whether a proposed technical objective or mission is valid in itself.

—Phase B—preliminary design. Again, the space agency would probably award parallel contracts, the official suggested. These would be to determine general design concepts, configuration, cost estimates—all directed toward a single project approach from among the alternate approaches resulting from Phase A activities.

—Phase C—work definition. At this point, NASA would make a hard decision on the final project concept, including system design and the breadboarding of critical systems and subsystems. Also to be considered would be the facilities required and detailed cost estimates by years.

—Phase D—final hardware design and development, fabrication, test and project operations.

At the conclusion of each phase, NASA officials will review the work accomplished before making a decision on the next step. Brackett pointed out, however, that in most cases a project would not advance into the third phase if it was not reasonably certain that the program would be completed. Also in many cases, the entire four-phase plan would not be used, but the program instead managed in two or three phases, Brackett said.

By space agency definition, programs requiring this step-by-step management control would be those major R&D undertakings requiring significant agency resources and involving important external relationships, and would typically encompass design, development, fabrication, test and flight operation of major aeronautical and space hardware.

Examples listed include the *Voyager* program, *Advanced Orbiting Solar Observatory* and other spacecraft of observatory complexity, the hypersonic ramjet experiment, further utilization of *Apollo* systems and post-*Saturn* launch vehicles.

● **DOD lends a hand**—Regional organization of the entire United States under a program for more efficient administration of both NASA and Dept. of Defense contracts will be completed by Dec. 1.

The Defense Contract Administration Service (DCAS) is completing organization of the nation's contractors into 11 geographical regions for management of the majority of defense and space contracts. The service, a semi-autonomous branch of the Defense Supply Agency, is headed by Deputy Director Maj. Gen. W. W. Veal. Executive director for contract administration is Col. W. E. Newby. Harold Pryor serves as director of the NASA/DSA Contract Administration Services Office at its headquarters at Cameron Station, Va.

Top NASA Procurement Personnel

NASA HEADQUARTERS WASHINGTON, D.C. 20546	
OFFICE OF PROCUREMENT	
Director	George J. Vecchietti
Small Business Advisor	Jacob M. Roey
Industry Assistance Officer	John K. Koepf
CONTRACTS DIVISION	
Procurement Officer	Albert A. Clagett
Small Business Specialist	Ralph T. Scroggs
AMES RESEARCH CENTER MOFFETT FIELD, CALIF.	
Procurement Officer	A. S. Hertzog
Small Business Specialist	John C. Delaney
GODDARD SPACE FLIGHT CENTER GREENBELT, MD. 20771	
Procurement Officer	Gordon H. Tyler
Small Business Specialist	Harry T. O'Toole
FLIGHT RESEARCH CENTER EDWARDS AFB, CALIF.	
Procurement Officer	Lloyd J. Walsh
Small Business Specialist	Stephen C. Kucharik
KENNEDY SPACE CENTER COCOA BEACH, FLA. 32931	
Procurement Officer	M. E. Haworth, Jr.
Small Business Specialist	Thomas M. Davis
JET PROPULSION LABORATORY PASADENA, CALIF. 91103	
Procurement Officer	T. W. Candee
Small Business Specialist	Forest S. Gibson
LANGLEY RESEARCH CENTER HAMPTON, VA. 23365	
Procurement Officer	Sherwood L. Butler
Small Business Specialist	Joseph F. Braig
LEWIS RESEARCH CENTER CLEVELAND, OHIO 44125	
Procurement Officer	F. H. Stickney, acting
Small Business Specialist	Norman C. Prahst
MANNED SPACECRAFT CENTER HOUSTON, TEX. 77001	
Procurement Officer	Dave W. Lang, Jr.
Small Business Specialist	H. T. Christman
MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALA. 35812	
Procurement Officer	Wilbur S. Davis
Small Business Specialist	Emil J. Havrilla
WALLOPS STATION WALLOPS ISLAND, VA. 23337	
Procurement Officer	Louis T. Birch
Small Business Specialist	Elton R. Scott
WESTERN OPERATIONS OFFICE SANTA MONICA, CALIF.	
Procurement Officer	Earl J. Sample
Small Business Specialist	Alex Mirosav
ELECTRONICS RESEARCH CENTER CAMBRIDGE, MASS.	
Procurement Officer	James B. Cahalane

Two regions in California, with headquarters in Los Angeles and San Francisco, are the last ones to be organized. Other regional headquarters are in Boston, New York, Philadelphia, Cleveland, Detroit, Chicago, Atlanta, St. Louis and Dallas.

Under the plan DCAS personnel in the regional areas handle all routine contract administration for the space agency and the military services. At this time, some 50 or 60 contracts are still under the control of individual services, but a majority of the NASA and DOD contracts are administered by DCAS.

NASA cooperation in the streamlined administration system began with a pilot test project (known as Project 60) in April, 1964. Some 201 NASA contracts in the Defense Supply Agency's Philadelphia region were placed under management of DOD personnel. Results showed that DOD could effectively administer NASA contracts in the field on a reimbursable basis. This meant a considerable savings for the space agency in both personnel and expenditures and put no undue burden on DOD.

Under the cooperative arrangement, one or two NASA personnel are represented in each region to act as coordinators and communications links with NASA. The men are not involved in the routine decision-making process, Brackett pointed out, but are there to advise and help out when needed. All report through Pryor to George J. Vecchietti, director of NASA's Office of Procurement.

The setup does not preclude NASA field centers from assigning technical people to the various contractor plants for assistance. But all routine management work is handled by the Defense group, Brackett emphasized.

● **NASA an afterthought**—The streamlined contract administration project was not initiated with the space agency in mind. It was conceived in 1962 to make defense procurement more efficient, and a policy committee was established to advise Defense Secretary Robert S. McNamara on the feasibility of centralizing DOD contract administration.

NASA was later invited to cooperate in the project in order to profit from DOD experience. An agreement formally establishing the cooperation stated its intention "to avoid, to the maximum extent, duplication of effort and to achieve the most effective and economical utilization of DOD and NASA resources in the performance of contract administration services in support of NASA."

Reasoning indicates, said Pryor, that the Dept. of Defense, with an estimated 20,000 people involved in contract management and a capability resulting from years of experience, can handle NASA contracts using fewer people per job than if the space agency tried to set up its own service. This means that in the end the Government will spend less in manpower, and accordingly less money, on administration of contracts.

The space agency, with a ceiling on the number of its personnel, can better use its people in scientific and technical applications, said Pryor. ■

A few pounds of Beryllium might have kept Hubert Latham out of the Dover Sea

Hubert Latham put his Antoinette monoplane to the ultimate test over the English Channel. He found that the plane had a maximum range of 29½ miles. Unfortunately, the Channel was 31 miles wide.

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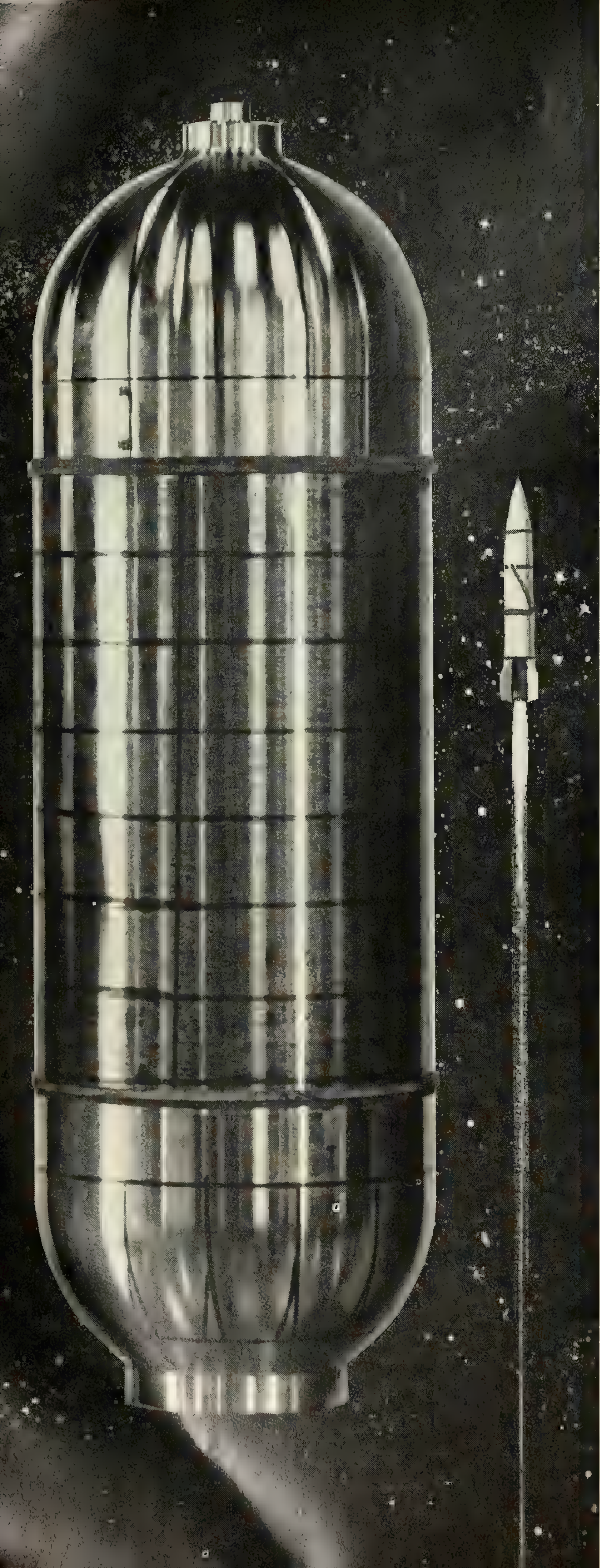

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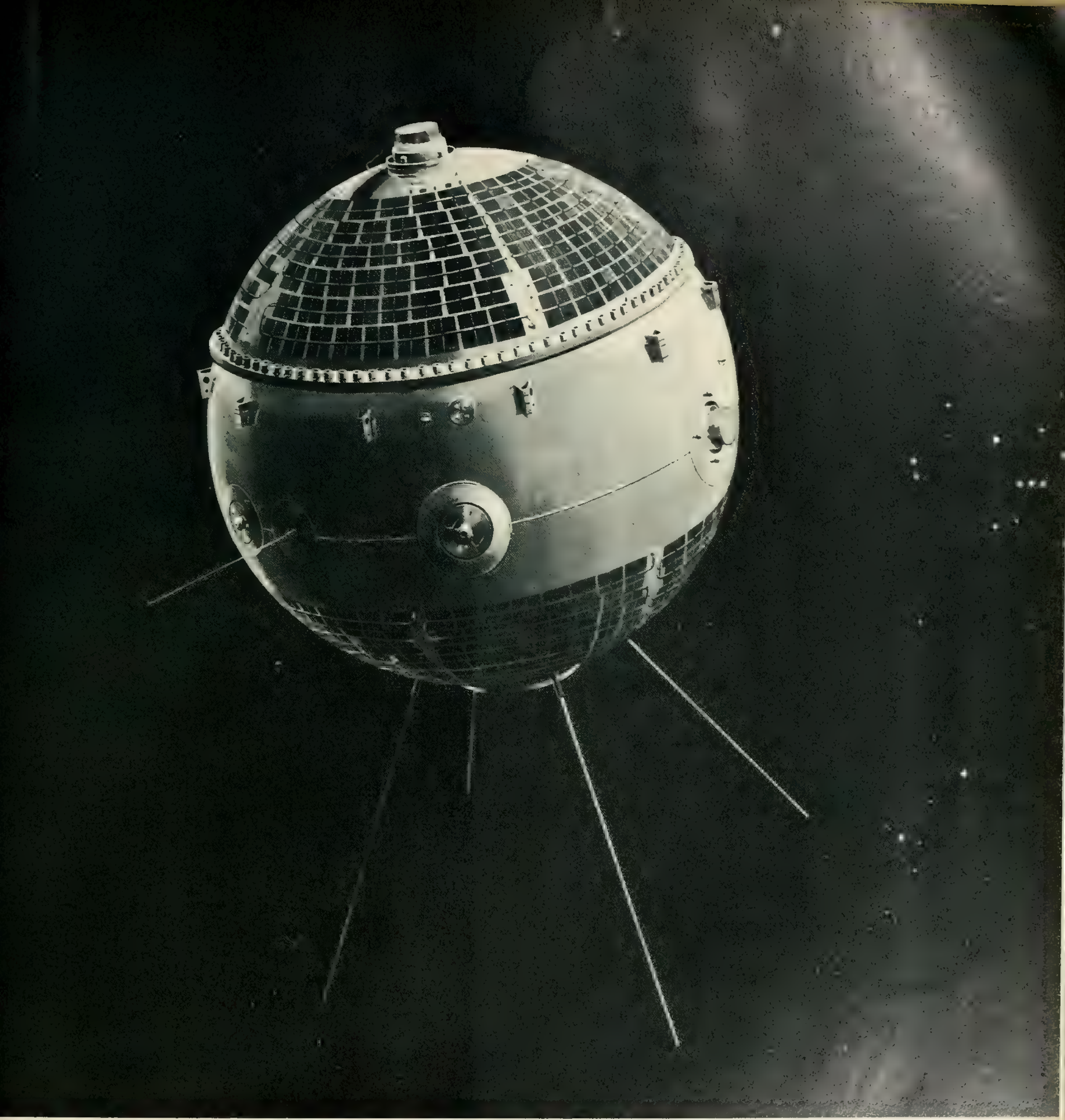


ATMOSPHERE Explorer-B (AE-B) to be launched in 1966 to make density and pressure measurements.

PART II

PROGRAMS

FY '67 To Bring Hardware Starts

Initial development funding should be about $200 million; projected four-year program might cost up to $6 billion

THE MODIFIED SPACECRAFT and experimental payloads of the *Apollo* Applications program (AA) will move into hardware development in the next fiscal year as the U.S. takes its first major new step in manned spaceflight since this country's manned lunar landing program was announced four years ago.

Funding for the first year development is expected to be about $200 million, according to NASA officials, if the agency's total budget for Fiscal Year 1967 is $5.2 billion.

If the NASA budget, because of the cost of the Vietnam war and new domestic programs, is reduced to $5 billion or below, AA will be delayed for one year.

The $200-million level for FY '67 is slightly less than half the more than $400-million *Apollo* Applications program NASA requested from the Johnson Administration and far below the $600 to $700-million program proposed by the U.S. scientific community.

It will, however, provide enough money to make the initial payment on the experiments and basic *Apollo* spacecraft for the six or seven flights in the program's first two years using unmodified *Apollo* Command, Service and Lunar Excursion Modules. It will also permit initiation of funding for long leadtime items on experiments and new hardware for the long-duration missions to be flown on extended *Apollo* spacecraft later in the program.

Based on a projected four-year program—on which NASA officials have arbitrarily agreed—the cost of the program is expected to average $1.5 billion per year or a total of $6 billion.

Because of the uncertainty about the size of next year's budget—which may not be finally resolved until early in January—the space agency is still in a state of flux as to the number of flights in the program and the experimental payloads that will be flown.

• **Flexibility dictated**—As a result, officials are preparing a program with a number of options (see chart page 50) to provide top-level management with the tools to make final decisions once the budget question is decided. The decision period is expected to stretch through much of the current fiscal year as NASA completes the systems definition phase of AA.

For planning purposes, NASA has prepared an optimum program that calls for 18 flights using modified *Apollo* spacecraft to extend its operational lifetime and another seven flights which would use standard 14-day orbital lifetime spacecraft left over after the U.S. manned lunar landing program is completed (see chart page 49).

At the same time, it has compiled a list of experimental payloads worth well over $1 billion which it plans to fly during AA missions. The most complete list of those experiments appears in the tables on pages 53 and 54.

Since the list was compiled a couple of months ago, many additional experiments have been proposed by NASA's Office of Space Sciences and Applications and added to the list, but the agency refuses to identify them until further justification for their inclusion in the program is obtained.

AA has three primary missions—14- to 45-day flights in Earth orbit, 14-day exploration missions on the lunar surface and 28-day orbital flights around the Moon. The extended operational capability is achieved by removing two propellent tanks from the *Apollo* spacecraft Service Module and replacing them with additional power and life-support supplies.

There is also room for some experiments in that module. For the 45-day flights and the extended staytime lunar surface missions, the ascent propulsion system is removed from the Lunar Excursion Module to provide room for experimental payloads and supplies for the lunar surface.

• **Recent program moves**—While the final decisions on the total scope of the program have not been made, NASA officials are taking decisive steps in a number of areas to complete systems definition in FY '66. Recent developments in the program include:

—The FY '66 authorization of about $50 million will be split about in half, with about $25 million earmarked for spacecraft and payload integration systems definition and the rest being used for experiments. Space agency officials report that the same breakdown will probably be made with FY '67.

—The FY '66 experiment breakdown includes $5.5 million for manned spaceflight experiments, $300,000 for advanced research and technology experiments and $12 million for space science experiments. In addition, $5.1 million will be spent on continuing experiment programs such as the scientific mission support study, $400,000; lunar drill, $300,000; local scientific survey module, $1.5 million; lunar probe, $1 million; data handling, $500,000; U.S. Geological survey mission, $400,000; emplaced station, $500,000; and lunar penetrometer, $500,000.

The Marshall Space Flight Center is expected to issue before the end of calendar 1965 a request for proposals on systems definition of the payload integration of the *Apollo* Applications spacecraft and its experiments. Two to four companies are expected to be selected for the first phase, which will last four to six months. Then one firm will be named as prime contractor for the work.

Manned Space Flight management plans for the program now call for Marshall to have field center responsibility for the payload integration for all experiments involving the Lunar Excursion Module. The Manned Spacecraft Center will have responsibility for payload integration of Command and Service Module experiments.

In addition, the Manned Spacecraft Center will have responsibility for mission control during flights. As a result, it is expected that two firms eventually will be named to do the payload integration job—one under contract to Marshall for LEM integration and one under contract to MSC.

—The experiments to be funded with FY '66 funds will be selected by March, 1966. Experiments to be funded from the next fiscal year's budget will be picked by October, 1966.

—One of the guidelines laid down for the program is that there are to be no self-contained modules included in the experimental payloads. Biomedical adherents, however, and astronomers are making a strong pitch—which will probably be successful—to have special laboratory modules to hold their experi-

(continued on p. 50)

SCIENTIFIC/TECHNICAL AREA	FIRST YEAR			SECOND YEAR							THIRD YEAR								FOURTH YEAR						
	E1	E2	E3	E4	E5	E6	E7	L1	E8	L2	L3	E9	E10	L4	E11	E12	L5	L6	E13	L7	E14	E15	E16	L8	L9
Category A:																									
Bioscience	①						②					②			○				○						
Biomedicine/Behavioral		○	○	○	○	○	①		①			○	○		②	○			○		○	②	①		
Operations Techniques and Advanced Mission S/C Subsystems	②			②	②		○		○			①			○				②				②		
Atmospheric Sci. and Tech.				●	①				②						①				①						
Earth Sci. and Resources				●	○				②						①				①						
Lunar Orbital								●						●						●					
Category B:																									
Astronomy/Astrophysics		②				②							①								①	○			
Physical Sciences		○	①			○							○			②						②			
Advanced Tech. and Supp. Res.		○	○			①										○					②				
Extravehicular Eng. Act.		①	②			○							○			①					○				
Communications and Navigation													②								○	①			
Lunar Surface										○	○						○	○						○	○

● Lunar Orbital Sensors ① Primary Flight Objective ② Secondary Flight Objective ○ Flight Carries Experiments of Specific Area
E1-E16 Earth Orbital Flights L1 - L9 Lunar Flights

PROBABLE optimum Apollo Applications program, which calls for 18 flights using unmodified Apollo spacecraft.

BREAKDOWN OF Apollo Applications experiment areas and NASA centers with major responsibility in each area.

			OMSF		OART				OSSA		OTHER AGENCIES			
		Scientific/Technical Area	MSC	MSFC	ARC	ERC	LRC	LeRC	GSFC	JPL	USDA	USGS	USN	USA
EARTH ORBIT		**Astronomy/Astrophysics**			▨		▨		Lead Center					
		Bioscience	▨		Lead Center									
		Physical Sciences: Environment					▨		Lead Center					
		Fundamental Investigation				Lead Center		▨						
		Biomedicine/Behavior	Lead Center		▨									
		Advanced Technology and Supporting Research	▨	▨	▨	▨	Lead Center	▨	▨					
		Extravehicular Engineering Activities	▨	Lead Center			▨							
		Operations Techniques and Advanced Mission Spacecraft Subsystems	Lead Center			▨	▨							
		Atmospheric Science and Technology					▨		Lead Center					
		Earth Science and Resources	▨			Lead Center			▨		▨*	▨*	▨*	▨*
		Communications and Navigation Traffic Control				Lead Center	▨		▨					
LUNAR	**ORBIT**	**Sensing of Lunar Surface**	▨	▨		Lead Center	▨		▨	▨		▨		▨
		Orbit to Surface Probes					▨			Lead Center				
	SURFACE	**Exploration/Geosciences**	▨	▨					▨	Lead Center		▨		
		Astronomy & Astrophysics							Lead Center					
		Surface Mobility/Mission Support		Lead Center										

▨ Contributing Center/Gov't Agency

*Definition and feasibility sequence will be accomplished via interagency transfer by USDA, USGS, USA (GIMRADA) AND USN (NAVOCEANO) ments, which would be repeated on several flights in the series.

—The so-called LEM shelter vehicle, which would permit extra staytimes on the lunar surface of up to two weeks, and the Local Scientific Survey Module (LSSM) will move into the systems definition phase in FY '67. The LEM truck vehicle, which would have carried 600 to 7,000 lbs. of supplies to the Moon to extend staytimes up to three months, is now considered too expensive by the space agency, which is turning with renewed interest to a direct assent mission to get supplies to the Moon.

—Officials feel that the Marshall Space Flight Center's multi-mission module vehicle, which would carry tens of thousands of pounds to the lunar surface, is the cheapest way of building a lunar base if a decision is made that such a base is desirable.

- **Timetable**—*Apollo* Applications flights are planned to begin in 1968 with three Earth-orbital missions. The program would then be completed by additional flights in 1969, '70 and '71. The initial flights, however, are based on availability of unmodified *Apollo* spacecraft from the U.S. manned lunar landing program. If these spacecraft are not available—which is possible because of delays that may creep into the lunar program—the first flights might have to be postponed until 1969.

The *Apollo* spacecraft's Command and Service Modules and LEM all have an inherent potential for increased capability to conduct in-flight experiments and offer considerable flexibility to meet the requirements of various AA missions. Propellant loading of both the *Saturn* S-IVB stage and the Command Module will be varied, exchanging a maneuvering capability in space for increased payload capacity. Also, the adapter section of the LEM includes almost 6,000 cu. ft. of unpressurized volume that will be used to carry large experiment payloads, such as an astronomical telescope or for an erectable structure such as an antenna. Experiment equipment will be installed in the unpressurized sections of the descent-stage structure, inside the LEM cabin and around the outside of the ascent stage pressure shell.

The LEM ascent stage main propulsion system can also be removed, providing more than 200 cu. ft. of laboratory space.

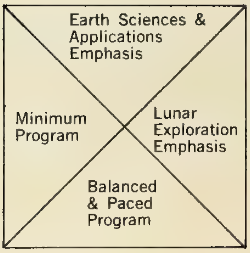
Within the Block II Service Module, a section has been kept empty to accommodate experiments. One design concept utilizing this space is called the experiment pallet. It would occupy 210 cu. ft. of unpressurized space and have a structural limitation of 5,000 lbs. total weight. Design studies have shown that approximately 3,500 lbs. of experiments in a volume of 115 cu. ft. can be carried, along with support equipment. This support equipment would include: an electrical power supply consisting of 400 lbs. of batteries supplying 35 kw-hr. of energy; a thermal control system using a water-cooling loop that can remove 1,600 BTU/hr. and maintain a temperature of 70° ±25°F; a data-handling system to store and transmit 51,200 bits/sec.; and controls and displays in the Command Module to permit astronaut operation of the experiments.

- **Program management**—In addition to the assignment of Marshall and the Manned Spacecraft Center to the payload integration and mission control aspects of the program, NASA has also decided on a management structure that will utilize the unique technical capabilities of its various centers in the systems definition and development of the experimental payloads for AA.

As soon as NASA's program office, either the Office of Manned Space Flight, the Office of Space Sciences and Applications and the Office of Advanced Research and Technology, has decided that an experiment is feasible, it will be assigned to a so-called lead center, which will then be responsible for its system definition. Other centers will have supporting roles to the lead center

APOLLO APPLICATIONS program mission assignment options.

EXPERIMENT AREAS	1ST YEAR	2ND YEAR	3RD YEAR	4TH YEAR	TOTALS
Technology & Operations	1 0 1 1	1 0 1 2	1 1 1 1	1 1 1 1	4 2 4 5
Biomedicine/Behavior	0 0 0 0	0 0 0 1	1 0 1 1	1 1 0 1	2 1 1 3
Astronomy & Space Science	1 0 1 1	1 0 1 1	1 1 1 2	1 1 1 1	4 2 4 5
Earth-oriented Sciences & Applications	1 0 1 1	2 1 1 1	2 1 0 2	3 0 1 2	8 2 3 6
Lunar Exploration	0 0 1 0	1 0 1 2	2 2 3 2	1 2 3 3	4 4 8 7
TOTALS	3 0 4 3	5 1 4 7	7 5 6 8	7 5 6 8	22 11 20 26

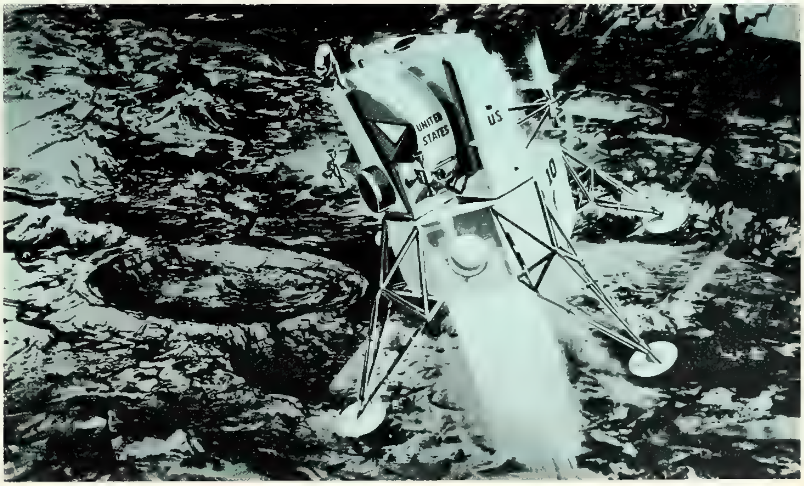

Earth Sciences & Applications Emphasis
Minimum Program
Lunar Exploration Emphasis
Balanced & Paced Program

Above Figures Represent Primary Payloads; Additional Experiments From Several Areas Will Be Carried on Most Missions.

Aerospace and Defense News

IDEAS AND CAPABILITIES REPORT FROM
RCA DEFENSE ELECTRONIC PRODUCTS

RCA PROVIDES NAVIGATION, COMMUNICATION EQUIPMENT AND ENGINE CONTROLS FOR LEM MEN ON TRIP TO THE MOON



When America's Lunar Excursion Module soars toward man's age-old goal, the moon, RCA mission analyses and space flight mechanics developments can claim credit for helping remove the trip from "Buck Rogers" fantasy. This vital work goes forward today in the Aerospace Systems Division of RCA's Defense Electronic Products, under subcontract to Grumman, the builder of the lunar excursion module.

Take navigation. RCA supplies LEM with its rendezvous radar and transponder, as well as its landing radar. Men inside LEM will communicate via the RCA subsystem with its S-band microwave, and steerable and erectable antennas, its assemblies for transceiver, power amplifier, duplexer, signal processor and VHF transceiver.

RCA At the Jet Reactivator and Descent Control

RCA also literally sits "at the jet reactivator and descent controls" of NASA's LEM. The RCA attitude translation and control assembly gives timing and sequencing signals to fire jets for attitude and translation control, as well as automatic turn signals for the gimbaled descent engine. This assembly supplies power, too, for the entire stabilization and control system.

RCA's descent engine control assembly goes into action as soon as LEM starts its power descent to the moon. It turns the engine on and off and controls the intensity and direction of its thrust. Along with the rest of LEM's descent stage, this assembly stays behind on the moon.

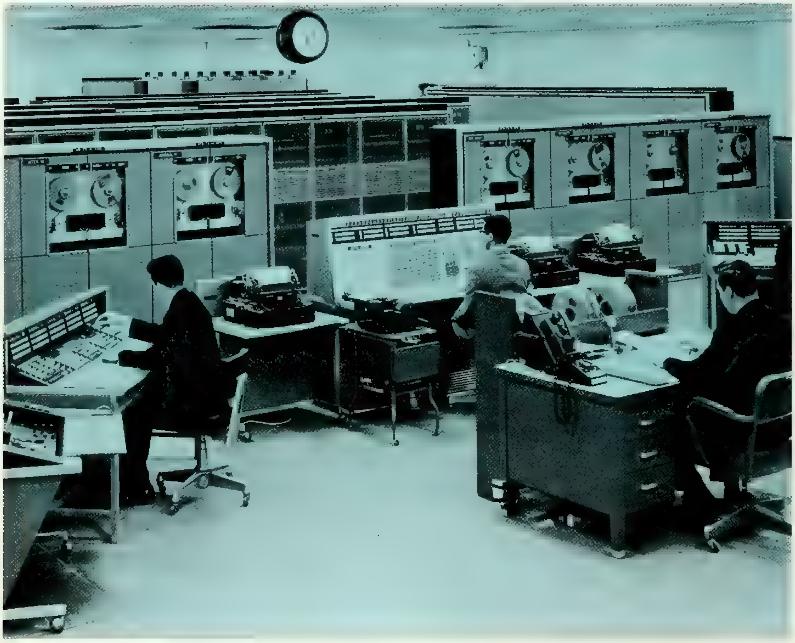
RCA Studied Human Factors

During the early stages of the project, human factors studies by RCA's Aerospace Systems Division made for Grumman Aircraft Engineering Corporation, provided a future picture of the astronauts' performance capabilities during rendezvous and docking maneuvers. In addition, the conditions of extra-vehicle visual environment have been projected by RCA simulation investigation on a 360-degree, non-programmed presentation and the specifications for a wide-angle, visual surround system for the LEM trainer.

RCA 110A COMPUTER SPEEDS PROGRESS TOWARD SATURN

Looking ahead toward on-schedule launching of the Apollo satellite early in 1966, National Aeronautics and Space Administration scientists at Huntsville, Alabama, rely extensively on several RCA 110A computer systems. They use them for real-time control and monitoring of the entire Saturn complex, including checkout at the launch site as well as simultaneous checkout several miles from the site at the launch control center blockhouse.

The RCA 110A is a serial 24-bit word binary computer operating at a 936 Kilocycle-per-second clock rate. Under program control, it is capable of two-way communication with peripheral equipment. In addition to conventional serial computer functions, special parallel input/output capabilities are included for control of 1008 discrete (relay driver) outputs, monitoring of 1512 discrete (contact closure) inputs, a wide range of DC and AC analog outputs (72 in quantity), a wide range of DC and AC analog inputs (300 in quantity), telemetry interface, 3 internal interval timers, several external clock inputs, and an interface with the spaceborne computer.



BOOSTING AUTODIN CAPACITY

AUTODIN, world-wide common user data communications system for DOD, is the world's largest and most advanced operational system of its kind. And, it's getting larger.

AUTODIN is undergoing its third major expansion (about 500%). The present 550 full duplex line network will be expanded to 2700 lines. The present Automatic Electronic Switching Centers (AESC's) will be expanded to 300 lines and 4 new AESC's will be added.

Each AESC comprises over 100 racks of RCA equipment, including line buffering units, computers, mass memory units, tape stations, consoles, etc., and occupies over 5,000 square feet of floor space. The system was designed to operate continuously, provides maximum message protection and transmission accuracy, and provides full message interchange capability among the scores of subscriber media, codes, formats, and speeds. Network performance is maintained consistently above 99%. Message traffic has increased from 1 to 6 million messages/month and is increasing continually. AUTODIN prime contractor is Western Union.

RCA STRUCTURES TO TAKE ON CHALLENGES OF AEROSPACE

- DEFENSE ELECTRONIC PRODUCTS
- ASTRO ELECTRONICS DIVISION
- AEROSPACE SYSTEMS DIVISION
- COMMUNICATIONS SYSTEMS DIVISION
- MISSILE AND SURFACE RADAR DIVISION
- WEST COAST DIVISION

Facilities, capabilities, resources in total depth. This is how RCA structures for defense and aerospace needs to come. Anticipating these, RCA Defense Electronic Products has organized a vast corps of scientific and engineering specialists along functional lines in its five major divisions, coordinating know-how with a sixth unit—Defense Engineering.

Each of these five divisions encloses broadly varied technological disciplines in product areas with programs which continually thrust forward into tomorrow. Each project is an especially dedicated mission into the nation's future in aerospace and defense developments.

ROOM-TEMPERATURE LASER TO TRANSMIT SPACECRAFT-TO-EARTH VOICE COMMUNICATION

RCA takes the laser out of the refrigerator, and frees it from conventional high-current pumping requirements. Result: A compact, lightweight and battery operated device.

Predicated on semiconductor circuitry, the new RCA laser utilizes 4 gallium arsenide (GaAs) transmitting diodes, developed at the RCA Laboratories, Princeton, N.J. These diodes achieve their laser action with the low threshold current of 8 amperes—and each diode is modulated by pulsing 40 amperes 8,000 times a second. Bandwidth is 3,000 cycles per second. Pulse duration is 70 nanoseconds. Duty cycle is approximately one-tenth of 1 per cent.

Though its average transmitting power is only 1 milliwatt, this laser's signal carries strongly through earth's atmosphere. That's because its light beam signal is extremely directive. Its 9,000 Angstrom beam is unaffected by daylight. The signal is received by a multiplier phototube and a parabolic mirror.

One of the new RCA-built lasers will transmit voice to earth from Gemini 7—scheduled for December orbit.

RCA Welcomes Inquiries

Welcome indeed at RCA are all inquiries about design and development of both systems and hardware. Further information on any phase of RCA skills and potentialities is easily available from Radio Corporation of America, Defense Electronic Products, Bldg. 2-6, Camden, N.J. 08102.

RCA ®

The Most Trusted Name in Electronics

in development of experiments.

The systems definition responsibility includes:

—Goals and rationale for the overall program and for each experiment.

—Selection of testable hypotheses.

—Specific experiments.

—Basic parameters to be measured, with required accuracy.

—Experiment plan, including individual experiments, number of flights, orbit deployment, operational requirements, data handling, scientific training of astronauts.

—Specifying equipment functional requirements, including block logic diagrams and preliminary engineering

(continued on p. 56)

Preliminary COMPATIBLE GROUPING OF PAYLOADS WITH INDIVIDUAL EXPERIMENTS August 2, 1965	4 Year Program															
Flight No. Saturn I-B ● Saturn V ■	E1 ●	E2 ●	E3 ●	E4 ■	E5 ■	E6 ●	E7 ●	E8 ■	E9 ●	E10 ■	E11 ■	E12 ●	E13 ■	E14 ■	E15 ●	E16 ●
Altitude (n. mi.)	200	200	200	200	Syn.	200	200	200	200	Syn.	200	200	200	200	200	200
Inclination (deg.)	28.5	28.5	28.5	90	0	28.5	28.5	83R	28.5	0	28.5	28.5	90	28.5	28.5	28.5
Duration (days)	14	14	14	14	14	14	14	45	45	45	45	45	45	45	45	45
Experiment Title																
Astronomy/Astrophysics																
EXISTENCE AND FEATURES OF EXTRATERRESTIAL LIFE																
SURFACE MAPPING, MORPHOLOGY, COMPOSITION; AND INTERNAL MECHANISMS OF ASTRONOMICAL BODIES																
0702 Intermediate Size Reflecting Telescope														●		
0703 Manned Coronagraph						●				●						
0705A Radio Astronomy 1-5 MCPS Range										●						
0705B Radio Astronomy 1-5 MCPS Using "V" Antenna														○		
TR4 Spectral Measurements of Radiation Orig. on Mars		●														
TR9 X-Ray Astronomy						●								●		
TR13 Manned Solar Observatory														●		
MECHANISMSOF ORIGIN AND EVOLUTION OF THE UNIVERSE																
0701 Emission Line Radiometry										●						
0704 Nearby Solar-Like Stars in X-Rays						●				●						
TR3 UV Photography of Star Fields & Emission Regions														●		
TR16 Mapping of the Celestial Sphere (1230-1700 Å)														●		
TR17 Extreme UV and Soft X-Ray Solar Spectrum Photog.														●		
Physical Sciences																
MEASUREMENT OF THE ENVIRONMENT																
0501 Radiation Environment Monitoring		●	●									●			●	
0502 Study of Magnetic Field Lines						●										
0503 Analysis of Comet-like Particulate Clouds			●													
0504 Micrometeoroid Collection						●										
0606 Cosmic Ray Emulsion			●													
TR7 Energy Spectrum and Intensity of Very Heavy Nuclei			●												●	
TR8 Micrometeorite Collection			●												●	
TR11 Geomag. Trapped Radiation in Atlantic Anomaly			●												●	
TR14 Airglow Horizon Photography			●												●	
FUNDAMENTAL INVESTIGATIONS																
0601 Capillarity Studies			●									●				
0602A Kinetics & Dynamics of Vapor/Gas Bubbles						●										
0602B Liquid Drop Dynamics Study						●										
0603A Pool Boiling in Long Term Zero G Environment			●												●	
0603B Nucleate Condensation of Fluids in Zero G			●												●	
0604 Density of Gradient of Fluid at Near Critical State			●												●	
0605 Crystallization Studies						●										
Advanced Technology and Supporting Research																
ACQUISITION OF DESIGN DATA																
Mechanical Design Data Acquisition																
1602 Observation of Echo Satellite				●												
JPL2 Optical Materials Test Program		●														
1303 Extendable Rod Performance Tests						●										
Fluid System Design Data Acquisition																
1506 Propellant Handling Techniques (Derivative)										●						
Thermodynamic Design Data Acquisition																
Chemical and Nuclear Engineering Design Data Acquisition																
1402 Cabin Atmosphere for LSS														●		
1403 Fluid Management Technology for LSS			●													
Electrical/Electronics Design Data Acquisition																
TESTING OF RESEARCH MODELS																
1407 On-Board Navigation & Guidance												●		●		
Extravehicular Engineering Activities																
MANNED ASSEMBLY AND TEST OF STRUCTURES																
1301 Effects of Space Environment on Structures										●						
1405 Orbital Test of Large Solar Cell Array										●						
1507 Extravehicular Assembly Operations			●													
DEVELOPMENT OF MANNED EXTRA-VEHICULAR MANIPULATIVE CAPABILITY																
1406 Optical Technology														●		
1502 Development of Manned Locomotion & Maneuvering		●														
1505 Maintenance & Repair Techniques			●													
1101 Launch of an Unmanned Satellite														●		
PROCEDURES FOR TRANSFER, LAUNCH AND RECOVERY																
1504 Personnel & Cargo Transfer Operations			●													
1506 Propellant Handling Techniques												●				
1603 Recapture of Syncom III										●						
Communications and Navigation/Traffic Control																
DETERMINATION OF CHARACTERISTICS OF THE PROPAGATION MEDIUM																
1201 Measurement of Radio Frequency Radiation															●	
1202 Wide Band Width Transmission in Space															●	
OPTIMIZATION OF COMMUNICATION RELAY SYSTEMS																
1302 Deployment of RF Reflective Structures										●						
1305 Deployment & Obs. of Gravity Gradient										●						
1306 Large Aperture Space Erectable Antenna															●	
1203 Satellite Relay for use in MSF Network Operations			●							●						
EVALUATION OF ADVANCED POSITION LOCATING TECHNIQUES FOR INTEGRATION WITH COMMUNICATIONS TO TRAFFIC CONTROL FACILITIES																

Preliminary

COMPATIBLE GROUPING OF PAYLOADS WITH INDIVIDUAL EXPERIMENTS

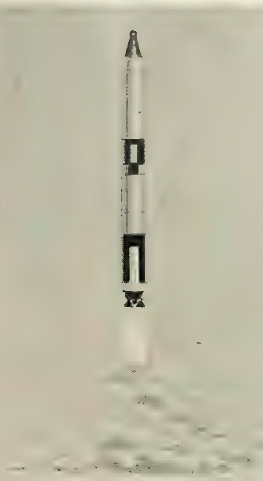
August 2, 1965

	4 Year Program															
Flight No.	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
Saturn I-B ● Saturn V ■	●	●	●	■	■	●	●	■	●	■	■	●	■	■	●	●
Altitude (n. mi.)	200	200	200	200	Syn.	200	200	200	200	Syn.	200	200	200	200	200	200
Inclination (deg.)	28.5	28.5	28.5	90	0	28.5	28.5	83R	28.5	0	28.5	28.5	90	28.5	28.5	28.5
Duration (days)	14	14	14	14	14	14	14	45	45	45	45	45	45	45	45	45
Experiment Title																
Biomedicine/Behavior		ø	ø	ø	ø	ø	ø	ø	ø	ø	ø	ø	ø	ø	ø	ø
Biomedicine																
SCIENTIFIC PHYSIOLOGICAL EXPERIMENTS																
0106 Carotoid Baroreceptor Reflexes			●			●										
0109 Pulmonary Function			●			●		●	●	●	●			●		
0110 Ventilatory Gas Exchange			●			●										
0114 Gastrointestinal Motility and pH													●	●		
0117 Human Neuro-Endocrine Function						●		●			●			●		
0120 Hemostasis			●	●		●		●		●	●					
DEVELOPMENT OF STANDARDS APPLICABLE TO SPACE MEDICINE																
0101 Sensitivity of the Otolith Function			●			●										
0102 Rotation of Head			●			●										
0104 Exercise (Work) Capacity			●			●		●	●	●	●			●		
0115 Thermal Regulation in Man				●		●		●								
DEVELOPMENT OF PREDICTIVE INDICES																
0103 Response of Human Circulatory Dynamics			●			●		●	●	●	●			●		
0105 Changes in Blood Volume			●			●		●	●							
0107 Alterations in Venous Compliance			●			●										
0111 Muscle Mass and Strength			●			●		●	●	●	●			●		
0112 Mineral Metabolism			●			●			●		●			●		
0113 Assessment of Nutritional Status			●			●		●	●							
0118 Hemic Cell Proliferation Distribution and Destruction			●	●		●		●	●	●	●			●		
0119 Hematological Defenses			●	●		●		●			●			●		
VALIDATION OF PROTECTIVE MEASURES AND REMEDIAL TECHNIQUES																
0108 Countermeasures to Prevent Circulatory Reflex Chgs.			●			●		●	●	●	●			●		
0116 Application of Water-Cooled Suit (deleted)																
DEVELOPMENT OF HYGIENIC STANDARDS FOR LONG TERM MISSIONS																
0121 Microbiological Evaluations						●		●			●			●		
Behavior																
ASSESSMENT OF PSYCHOMOTOR/SENSORY/COGNITIVE FUNCTIONS																
0201 Sensory - Perception Processes			●	●												
0202 Psychomotor Functioning			●	●		●										
0203 Higher Mental Functions				●		●		●	●	●	●			●		
OVER-ALL ASSESSMENT OF BEHAVIOR																
VALIDATION OF HUMAN ENGINEERING DESIGN FOR SPACE SYSTEMS																
VALIDATION OF IN-FLIGHT MAINTENANCE																
Habitability																
Operations Techniques & Advanced Mission Spacecraft Subsys.	⊙															
CREW SYSTEMS																
1401 Personal Hygiene & Food Technology				●					■							
1501 Evaluation of Adv. Space Suit Assemblies					●											●
SPACECRAFT SYSTEMS																
1001 Small Maneuverable Satellite					●				●				●			
1304 Ops. of Solar Sailing Pass. Comm. Satellite					●											
TECHNIQUES FOR PROVIDING ARTIFICIAL GRAVITY																
0301 Artificial G by Rotating Station				●												●
0302 On-Board Centrifuge								●								
DEVELOPMENT OF ADVANCED OPERATIONS TECHNIQUES																
1503 Emergency Techniques, Eqp. & Proc. for Rescue Ops.				●												
1601 Orbital Maneuvering & Docking (Phase I & II)							●						●			
Atmospheric Science and Technology																
UPPER ATMOSPHERE COMPOSITION AND PROCESSES																
0802A Operation of H-R IF Radiometer Det. Equip.								●			●		●			
LARGE SCALE DYNAMICAL PROCESSES																
0802B Test of IF Scanning Spectrometer								●			●		●			
0802C Calibration & Eval. of Microwave Spectrometer								●			●		●			
0802E Wind Velocity								●			●		●			
0802D Test of Prototype Star-Tracker								●			●		●			
CHARACTERISTICS OF SEVERE LOCAL STORMS																
INFLUENCE OF EXTRA-TERRESTRIAL EFFECTS ON WEATHER OCCURRENCE																
0801 Conjugate Aurora and Airglow					●											
ATMOSPHERE POLLUTION ANALYSIS																
Earth Sciences and Resources																
Agriculture/Forestry	As presently defined all four of these areas are supported by experiments 0901, 0902, 0903															
Geology/Hydrology																
Oceanography/Marine Technology																
Geography																
0901 Multi-spectral Target Characteristics											●		●			
0902 Synoptic Earth Mapping								●			●		●			
0903 Multi-frequency Radar Imagery								●			●		●			
Bioscience	⊙															
ENVIRONMENTALLY INDUCED CHANGES IN BIOLOGICAL MATERIAL																
0401 Genetic Effects in Microorganisms									●							
0402 Effects of Space on Unicell Org. & Animal Tissue									●							
0404 Limb Regeneration & Wound Healing							●									
PHYSIOLOGICAL RESPONSES TO WEIGHTLESSNESS IN ANIMALS																
0403 Effects of Weightlessness in the Primates													●			
0405 Effects of Drugs on Mammalian Behavior									●							
TR6 Otolith Function in Frogs							●									
COLLECTION AND SURVIVABILITY OF MICRO-ORGANISMS IN NEAR-EARTH SPACE																
0406 Space Borne Microorganisms													●			

ø Basic Biomedical/Behavioral package included.

⊙ Tentative allocation, actual experiments to be determined.

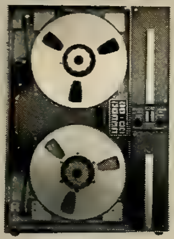
WHEN YOU DON'T GET A SECOND CHANCE !



OR YOU JUST HAPPEN TO LIKE IT RIGHT THE FIRST TIME!

TRY ONE OF THESE...

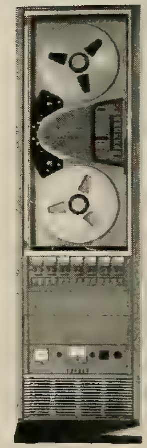
• 2.0 MC at 120 ips **• 0.3 μSEC** absolute time displacement error



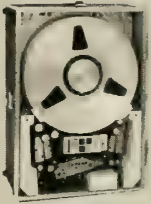
P-5000

- THE ONLY FIELD PROVEN 2.0 MC PORTABLE
- BI-DIRECTIONAL OPERATION
- 0.3% PK-TO-PK FLUTTER, DC-10KC AT 60 IPS.
- FIVE ELECTRICALLY SELECTABLE SPEEDS

L-6000



- 0.3 MICROSECOND ATDE AT 60 IPS LOWEST AVAILABLE ABSOLUTE TIME DISPLACEMENT ERROR
- 2.0 MC AT 120 IPS
- BI-DIRECTIONAL OPERATION
- 0.25% PK-TO-PK FLUTTER, DC-10KC AT 60 IPS



P-4000

- ONE CUBIC FOOT AND 50 POUNDS, SMALLEST AND LIGHTEST WIDE BAND RECORDER/REPRODUCER
- LOWEST POWER, 75 WATTS
- 1.5 MC AT 120 IPS
- FIVE SPEEDS

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Washington, D.C. 20006
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TWX: 710-822-9558

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Hyer Electronics Company
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Telephone: 303-771-5285

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Telephone: 505-268-6744

Wild & Associates, Inc.
Syosset, Long Island, N.Y.
Telephone: 516-921-7100

Circle No. 25 on Subscriber Service Card

WE'RE PROUD!

SPATRON POWER SUPPLIES AND MAGNETIC COMPONENTS RELIABILITY PROVEN AGAIN AT NORTHROP—NORTRONICS

NORTRONICS 500 EAST ORANGETHORPE AV.
A DIVISION OF NORTHROP CORPORATION

30 June 1965

Spatron, Incorporated
715 South Raymond Avenue
Alhambra, California 91803

Attention: Mr. John Singleton, President

Gentlemen:

SPATRON products participated in the "...51,500,000 hours actual field operations ...resulting in MTBF (mean time between failure) of more than 82,500 hours."

We're naturally proud of our contribution to the Naval Ballistic Missile Program in cooperation with Nortronics and Lockheed.

SPATRON
INCORPORATED
715 So. Raymond Ave.
Alhambra, Calif. 91803

Circle No. 26 on Subscriber Service Card

design of critical components and structures, documented by engineering sketches.

—Key technology areas that need advancement in the state of the art.

—Feasibility models or breadboards as required to demonstrate experiment feasibility or to allow specifications of flight equipment key requirements.

The lead center will also conduct required supporting research and aircraft/laboratory assessment of key experiment techniques and assure participation of the necessary segment of the scientific/technical community.

- **Lead center's role**—Once the systems-definition phase has been completed, the lead center will also be responsible for implementation of the experiment including:

—Development and procurement of required, flight-qualified sensors/equipment including: Detailed design, long-leadtime items, prototypes, flight hardware fabrication, test and acceptance.

—On-schedule delivery of flight hardware to the appropriate payload integration center.

Current NASA thinking as to the assignment of lead center and supporting center responsibility in the various experimental areas is documented in the chart on page 49.

- **Experiment approval sequence**—In another recent action, NASA established the route an experiment will take from the time it is approved until it finally becomes part of an AA flight.

Experiments will be proposed by either universities, NASA itself, another Government agency, or industrial firms to the appropriate program office in either the offices of Space Sciences and Applications, Manned Space Flight, Tracking and Data Acquisition, or Advanced Research and Technology.

A NASA official told MISSILES AND ROCKETS that it is expected that 80% of the experiments will be proposed to the Space Science and Applications Office, with almost all the remainder being in Manned Space Flight. It is expected that a relatively few will be in the Advanced Research and Technology or tracking areas.

If the program office believes it feasible, the experiment will be sent to the Manned Spaceflight experiment panel. After reviewing the experiment, the panel, if it approves, will recommend to Associate Administrator Dr. Robert C. Seamans funds be allocated for a feasibility study. The program office will then assign the experiment to a NASA field center, which will give the experimenter the go-ahead for a feasibility study.

When the study is completed, it will be reviewed by the field center, and if approved, a flight program will be recommended to the responsible program office and finally the Manned Space Flight experiment board. When the experiment has been developed, it will then be delivered to the field center that has responsibility for payload integration of experiments in that technical area. After integration into the spacecraft, it will then be delivered to Cape Kennedy for launch.

- **Scientific and technical experiment areas**—NASA officials now have about 350 separate experiments in the feasibility study phase and many more are expected to be added later. Many Earth orbital experiments are being added after being proposed by the Office of Space Sciences. In the lunar surface and lunar orbit areas, NASA hopes to have a meaningful list of experiments in January.

The major areas of interest for Earth orbital experiments are astronomy/astrophysics, bioscience, biomedicine/behavior, advanced technology and supporting research, extravehicular engineering activities, operations techniques and advanced mission spacecraft subsystems, atmospheric science and technology, Earth sciences and resources and communications and navigation-traffic control.

In the lunar surface field, identified areas of interest are geological, geophysical, geochemical and engineering investigation, astronomical observations, radiation measurements and surface mobility and mission support. Lunar orbital experiments include remote sensing of the lunar surface and direct surface measurements with orbit-to-surface probes.

For planning purposes, NASA has laid out a total of 16 flights in Earth orbit, seven with unmodified 14-day-duration *Apollo* spacecraft, and nine flights with 45-day missions. Included in the 16 flights are two synchronous-orbit flights—one 14 days and the other 45 days. All nine lunar orbit and surface missions will use extended capability spacecraft.

The missions of almost all of the Earth-orbit flights are now pretty well defined, including plans for a rendezvous mission later in the program that would extend *Apollo* Applications capability up to 135 days.

Primary mission of the first Earth orbital flight (E-1) will be remote sensing of the Earth's surface from a 200-n.-mi. orbit. The flight will carry medical, artificial gravity qualification and Earth-mapping experiments in the visible and near-visible spectrum.

The E-2 mission will be a 30-day biomedical/behavioral and technology flight with lunar-orbit survey system qualification from an altitude of 200 n. mi.

The 45-day E-3 is a bioscience/physical science laboratory mission to study effects of prolonged weightlessness and zero-gravity behavior of solids, liquids and gases. Plans for E-4, a space operations/bioscience laboratory mission, include a rendezvous with E-3 involving extravehicular cargo and personnel transfer, rescue operations, spacesuit evaluation and spaceflight effects on biological systems. E-5 is designed for remote sensing of the Earth's surface and atmosphere. Typical experiments and equipment include Sun-synchronous; multi-spectral sensors; solar-cell array, erection and orientation.

According to plans, E-7 will be an artificial-gravity laboratory mission for evaluation of human performance in a rotating environment. Mission E-8, like E-5, will involve remote sensing of the Earth, plus Command and Service Module inspection of the *Echo II* satellite.

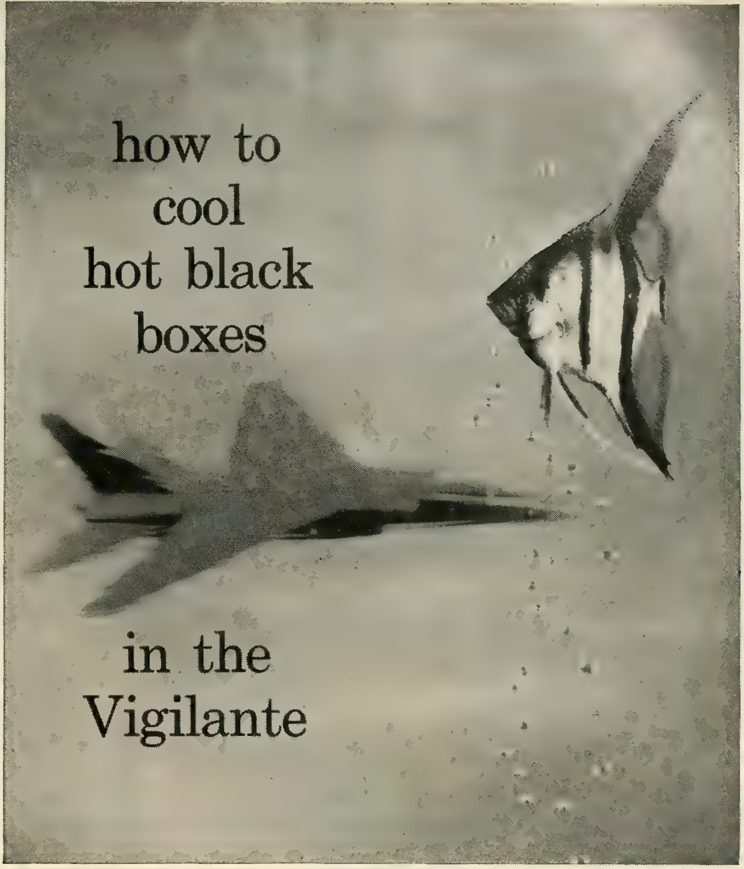
E-9 will be a space physics and subsystem development mission at an altitude of 19,350 n. mi. to study the space environment near Earth, e.g., aurora, magnetic fields, micrometeoroid fluxes, life support, communications and satellite launch.

An astronomy/bioscience laboratory is planned for the E-10 mission and will carry astronomy, optical and radio equipment. The E-10 mission will also include a rendezvous with E-11, an astronomy/logistics and bioscience laboratory. Included will be cargo and personnel transfer and the study of biomedical effects of flight duration beyond 45 days. E-11 will continue the astronomy observations on E-10.

Mission E-12 will be another astronomy/logistics laboratory. Plans include a rendezvous attempt with E-11, which will extend mission duration to a total of 135 days. Studies will involve cabin atmosphere and propellant handling.

E-6, the 45-day synchronous orbit mission, would have as its primary goal astronomical observation. The high 19,350 n. mi. orbit would allow optical astronomy free of atmospheric distortion. It would also allow radio wavelength observations to be extended below 1 cm, where atmospheric absorption by oxygen and water vapor begins, and above about 30 meters, where reflection of longer waves in the ionosphere takes place.

The payload for the astronomy missions could be composed of an optical telescope with suitable filters and cameras to operate in both an imaging and spectrophotometric mode; a radio-telescope to measure radio wave flux and spectral properties at wavelengths of 1 cm or less; a low-frequency antenna for measurements at wavelengths of 30 m or greater; and a space radiation telescope to measure cosmic ray and gamma ray flux and energy spectra. ■



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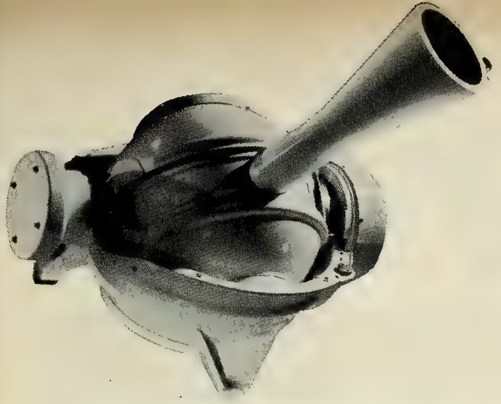

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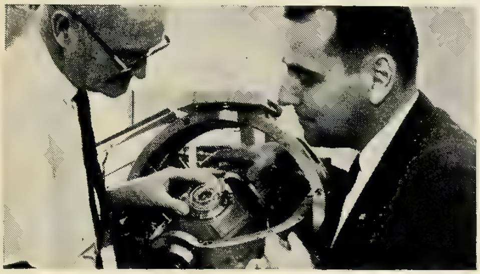

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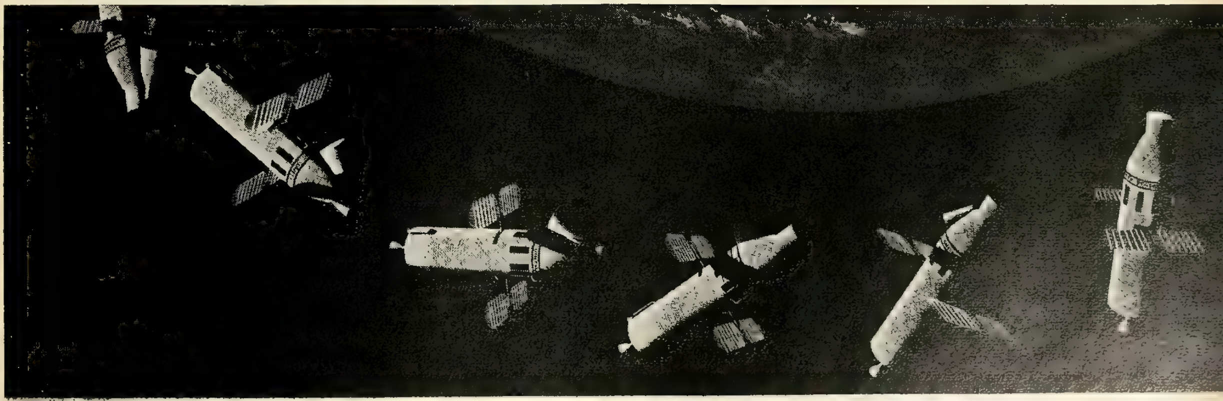

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FY '67 Request Seen as $150 Million

Most of funding earmarked for major orbiter development; early effort on lander, atmospheric probe also included

NASA's FISCAL YEAR 1967 budget request is expected to include about $150 million for Project *Voyager*, the program to place unmanned and heavily instrumented payloads in orbit around, and on the surface of, the planet Mars.

Most of the funds will be applied to initiation of major development of the *Voyager* spacecraft that is to be placed in orbit around Mars. There will also be a start on early development of both a Mars landing capsule for the intended 1973 surface exploration mission, and a less complex probe to be launched from the spacecraft into the Martian atmosphere during the first *Voyager* flight, in 1971.

Project officers stress, however, that any cuts in the FY '67 request will be felt first in the level of effort applied to capsule development.

The $150 million estimated as the budget request for FY '67 actually represents what probably will be the average expenditure for the program over its current seven-year projection, if the cost remains within the $1.3-billion total estimate. Some $300 million of the total has been projected for booster costs.

Voyager received $43 million in FY 1966. Peak years will come in FY '68 and '69, when expenditures are certain to rise above $150 million.

The slide down the other side of the spending curve on *Voyager* should come in the 1970 period, but the degree by which it declines—if it does—will be determined by the plans for post-1973 launchings.

Project managers say that these post-1973 missions probably will receive initial funding in FY '69 and '70. In NASA's view, there certainly will be further exploration of Mars with larger and larger capsules during the 1975 and 1977 opportunities. The attempt to get biology equipment onto the surface probably will be a major portion of that effort.

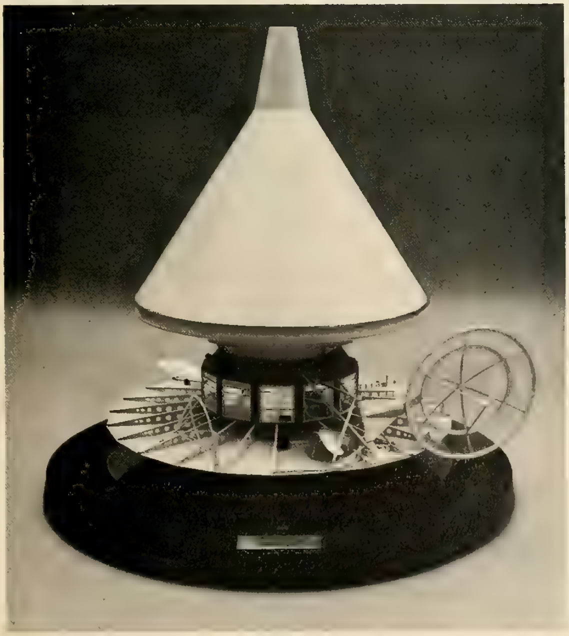
Planners say the space agency is also likely to begin looking at use of the *Voyager* spacecraft for Venus-orbital probes or fly-by missions, possibly in 1972-74, with earliest studies getting under way next year.

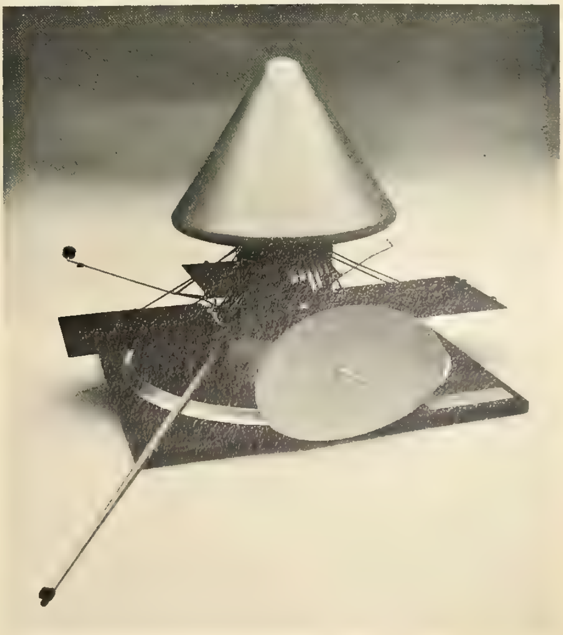
- **Overhaul**—The apportionment of FY '67 funds actually reflects the major reorientation of the project which has taken place during the past three months (M/R, Oct. 4, p. 14; Oct. 18, p. 15; Oct. 25, p. 17).

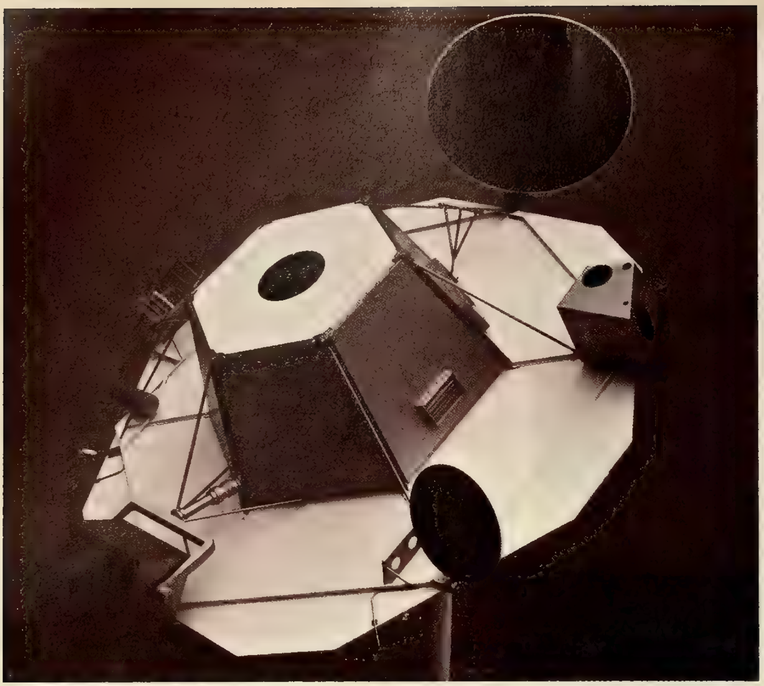
The impetus for this reorientation has come primarily from analysis of *Mariner IV* findings concerning the Martian atmosphere and similar ground-based spectroscopic measurements. Both inputs portray a Martian atmosphere much less dense than had been anticipated. The surface pressures indicated by *Mariner IV* in mid-July and the ground-based measurement span a range of 5-8 millibars. A range of 10-14 had been expected.

This fact, in combination with other changes which space agency officials say "became desirable" as a result of project definition work already carried on, has resulted in the following alterations for *Voyager*:

LEFT: GE Voyager model with fixed solar panels and steerable high-gain antennas. RIGHT: Boeing model, with deployed solar panels, magnetometer boom and steerable high-gain antennas. Cone on top of each model is payload capsule.







VOYAGER entry designed by TRW Systems Group has steerable high-gain antennas and fixed solar panels. Payload capsule, which mounts on top, is not shown.

—Shift in launch vehicle from the *Saturn IB-Centaur* combination to *Saturn V,* with the result that there will be a single *Saturn V* launch at each launch opportunity, rather than two *Saturn IB-Centaur* launchings. Mars launch opportunities occur every 25.8 months, with about a one-month launch window. To keep the number of spacecraft intact, NASA will launch two complete planetary vehicles aboard each *Saturn V.* The planetary vehicle includes the orbiter spacecraft and the landing capsule.

—Cancellation of the previously planned test launching in 1969.

—Extension of existing Phase 1A contracts now in force for a two-month period, to allow contractors funded in this phase to make adjustments reflecting the new findings and decisions.

—Postponement of the first fully instrumented capsule landing on Mars from 1971, as originally planned, to 1973, with a resultant delay of about a year in initiation of major development.

—Initiation of studies within the space agency of several possible payloads for the 1971 mission which could serve as useful Martian probes, to take maximum advantage of the 1971 flight and keep within the time frame allowed for development.

Despite the extent of the changes already made, NASA project officers stress that there may be more, and that the purpose of the definition phase on these programs is aimed exactly at this type of re-evaluation, to ensure that the final approach is the optimum one.

The *Voyager* program, through the 1973 missions, will cost at least $1.3 billion. Here are the milestones which now characterize NASA planning:

- **Spacecraft development**—Extended Phase 1A studies awarded early this month to the three contending *Voyager* contractors—Boeing Co., General Electric Co., and TRW Systems Group—will be submitted to NASA early in January. The space agency will then issue additional RFP's for Phase 1B, which involves detailed systems design.

NASA hopes that response to the Phase 1B proposals will allow it to choose a single contractor to move into Phase 1B in June, 1966. This phase will probably be concluded at the end of 1966, and award of the major contract for full-scale development of the spacecraft under phase II of the program would begin early in 1967.

- **Scientific mission capsule development**—NASA's original hopes of bringing industry aboard on this portion of the project as early as September, 1965, were altered by the *Mariner IV* data. The first step in the procurement cycle for this heavily instrumented 1973 lander now will not begin until next fall, when RFP's for first development phase will be issued.

While the lander mission has now been deferred by two years, from 1971 to 1973, and the procurement cycle by one year, NASA officials feel more comfortable about ultimate success of the mission since gaining an additional year for design and development.

- **Atmosphere probe development**—Though the first scientific capsule landing on Mars is delayed until 1973, *Voyager* Project Manager Donald Hearth told MISSILES AND ROCKETS that "we will leave the door open for the next several months for some kind of probe associated with the 1971 orbiter mission." NASA in-house evaluations, now in progress, are focused on about five possibilities, all of which would gather some additional Martian atmosphere data.

They range from a very simple, non-survivable probe, such as has been proposed by NASA's Ames Research Center, to a more complex device that might even survive impact upon the planet and function for a few hours. Hearth said it is conceivable that the 1971 probe "may get close to the 1973 lander prototype in design."

He also told M/R that a decision will be reached on this probe next spring, and that there is at least a possibility that NASA may do the development work in-house.

- **Experiments**—Proposals for experiments to go aboard the 1971 orbiter were due at NASA two weeks ago. In June, the space agency had informed some 4,000 potential experimenters of the opportunity to put their packages aboard *Voyager.* Hearth says the response has been "excellent," with some 170 proposals turned in several weeks prior to the deadline.

A tentative selection of experiments will be made in the spring, he says, and a final selection should be made by mid-1966. Funding would also begin at that time. Some of the proposed experiments are already being supported by other space agency offices.

- **Saturn V implications**—Of all the changes introduced into *Voyager* of late, none is apt to have more immediate or long-range impact than the use of *Saturn V.* It will allow larger payloads earlier in the program, a wider choice of flight plans for entering the Martian atmosphere, and more experienced planning of subsequent *Voyager* flights to Venus and possibly other planets.

The decision to use *Saturn V* grew out of concern for both the basic booster problems posed by *Saturn IB-Centaur* and the difficulties presented by entry into an atmosphere considerably less dense than had been anticipated.

NASA officials were troubled by the lack of projects other than *Voyager* which would use the *Saturn IB-Centaur*

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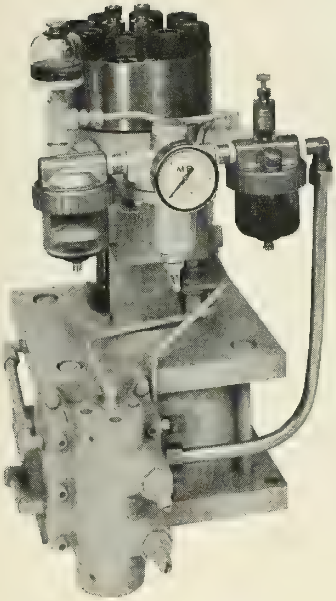

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combination and thus help to justify the cost of mating the two vehicles. There were also some still-unsolved technical problems in integrating the two, according to NASA. Furthermore, there was the knowledge that eventually more complex and heavier landing capsules would be needed, and that at some time there would have to be a switch away from the *Centaur*. This was accelerated when it became clear that landing problems would require a new approach and that relatively simple and lightweight capsules might not be acceptable for the scientific mission.

Prior to the decision to use *Saturn V*, the Air Force's *Titan III-C* was also considered. It was dropped due to payload-weight factors.

NASA project officers say in defense of the high unit cost of the *Saturn V* that its *Apollo* man-rated status will provide high reliability, and that its use to launch two spacecraft simultaneously compares favorably with two separate launchings using other boosters. The test flight in 1969 was also scrubbed because of expected *Saturn* reliability and because the cost of that flight would not justify the amount of data that could be gathered using spacecraft developed in so short a period of time. Use of *Saturn V* will also defer booster procurement costs until FY '69.

Saturn V has opened up what *Voyager* project managers feel will be one of the most advantageous ways to land sophisticated instrument packages on Mars. With the payload available on *Saturn V*, scientists say, the lander can be carried into Mars orbit together with the main spacecraft.

By keeping the spacecraft and lander in orbit around the planet for three to four orbits, coordinates of the orbit can be refined, possibly by Deep Space Instrumentation Facility (DSIF) tracking or an on-board planetary guidance system, to allow precise control over the capsule entry angle. A shallow entry angle is best suited for the capsule within the thinner atmosphere.

- **Propulsion**—Bringing the lander into orbit with the spacecraft bus will require a propulsion system for *Voyager* significantly larger than the one originally planned. Hearth says this system could weigh as much as 10,000-15,000 lbs. and would probably use Earth-storable fuels.

NASA has not yet made a decision on what type of system to use, nor exactly what the demands upon it will be, pending a decision on whether or not the capsule is to be put into Mars orbit. That concept, however, is considered most likely.

The space agency is also looking at the possibility of adapting the *Titan III* Transtage and the LEM descent engine for the *Voyager* propulsion module.

The developer of this module will be a subcontractor to the firm winning the prime spacecraft contract.

Whatever the decision on spacecraft propulsion, Hearth stresses that the capsule will not have a large propulsion system. He feels strongly that most of the ΔV that has to come out of the capsule prior to landing can be removed by aerodynamic braking, using the shallow re-entry angles, despite the thin atmosphere. Hearth feels that all but a few thousand fps can be removed aerodynamically, and that parachutes still are the most likely descent mechanism. Though NASA is also studying the use of landing rockets, Hearth says it is conceivable that the only propulsion system on the capsule will be small engines used to de-orbit the craft. JPL scientists, however, express some concern over Mars surface winds, and have launched a component protection study to guard against impact damage.

Overall guidance for the mission, say JPL scientists, must be accurate enough to enable a landing point to be reached with a three-sigma dispersion of 500 km, the goal being to land within 300 km of the selected target area. They doubt that there will be a tighter specification of a landing area for the first missions.

- **Spacecraft plans**—*Voyager* officials say there is no radical difference between any of the three company proposals put forth to date on the spacecraft, and that these do not depart in any great measure from designs proposed by JPL. Functionally, says Hearth, all have the same subsystems and are similar in concept, though not in size, with the *Mariner* spacecraft.

Whereas *Voyager* will make the same 8-9 month trip to the vicinity of Mars as did *Mariner*, it will remain in orbit around the planet for at least six months, which will allow its sensors to operate over a complete Martian season. High-resolution photography, IR and UV spectroscopy, and particle and field measurements will be performed from orbit.

The *Voyager* orbiter will weigh between 2,000 and 2,500 lbs, according to Hearth, and the 1973 lander will weigh between 3,000 and 4,000 lbs. At this point, there is no weight estimate for the 1971 probe, except that it will be lighter than the lander being planned for 1973.

The *Voyager* orbiter experiment payload will be between 200-300 lbs., 10 times the size of the *Mariner* experiment package. The communications system, limited to about 8 bits per sec. for *Mariner*, will be upped to at least 2,000 bps for *Voyager*. Because of the time spent in orbit and the increasing distance as the planet moves farther away from Earth, data-storage capabilities will be increased from roughly 5 x 10^6 for *Mariner* to 10^8 bits for *Voyager*.

Total on-board power will be about 500-1,000 watts at Mars. Later, capsules will have much more extensive power requirements when on the surface.

The orbiter will require a moveable high-gain antenna, according to JPL engineers. This will be somewhat larger than that on *Mariner IV*, and the principal limitation on its size will be aiming accuracy. One proposal reportedly suggests a parabolic antenna measuring 12 ft. 2 in. by 8 ft. 2 in.

- **Elliptical advantages**—No particular orbit has been chosen for the 1971 mission, since this depends on the experiments carried on the spacecraft, but the orbit is likely to be highly elliptical. Less energy is needed to achieve such an orbit, and it would be well suited to the data-handling requirements. The orbiter will gather large amounts of data as it gets close to the planet, and will spend the rest of the orbit transmitting to Earth at a lower rate. Data-storage requirements will be high, as the orbiter will gather as much data during each orbital pass as *Mariner IV* did during its fly-by.

The orbiter will use solar cells, probably fixed panels, for power, augmented by silver cadmium batteries for peak power periods. Hearth says attitude will be controlled with a cold-gas system similar to that of *Mariner*, and stabilization electronics will involve the traditional Earth-Sun-Canopus fix.

Hearth reports, however, that two mid-course corrections are likely to be made on *Voyager*, as opposed to the solo correction used for *Mariner*, for more precise control. Spacecraft command and sequencing mechanics are also certain to be more complex, since the orbital operations and time in orbit will be more severe.

Management of the *Voyager* project is also similar to that of *Mariner* in many respects—with one very important exception. A NASA procurement group has been set up and is now in residence at JPL. This group will, for the first time, be the contracting agency for the two prime *Voyager* contracts—the spacecraft and the lander—putting the full weight of the Government, rather than the academic community, behind the development effort.

Management responsibility for the *Voyager* spacecraft and lander remains in the hands of the Jet Propulsion Laboratory, with support from both the Ames and Langley Research Centers.

The JPL staff for *Voyager*, now at 375 people, is expected to grow to between 800-1,000 in the next three years.

On top of the JPL effort at NASA headquarters are Hearth and his program management staff. ■

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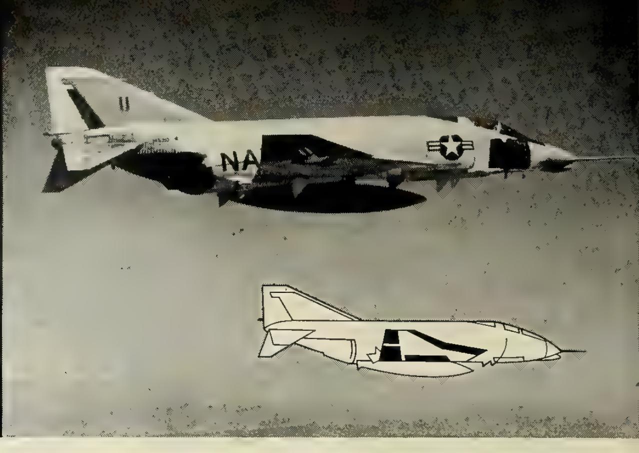

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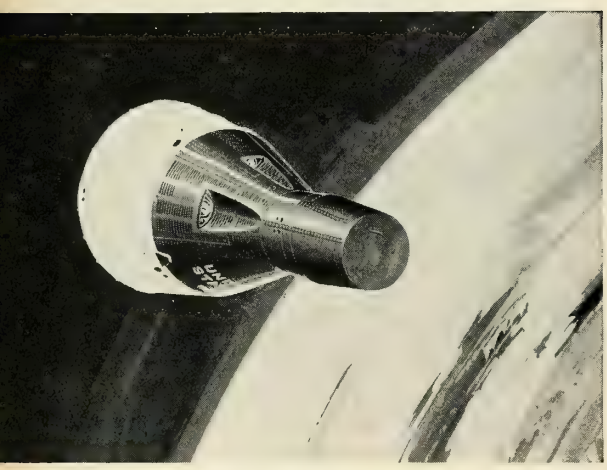

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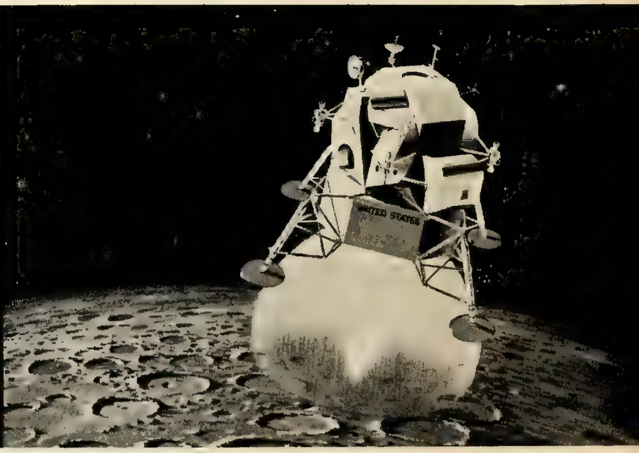

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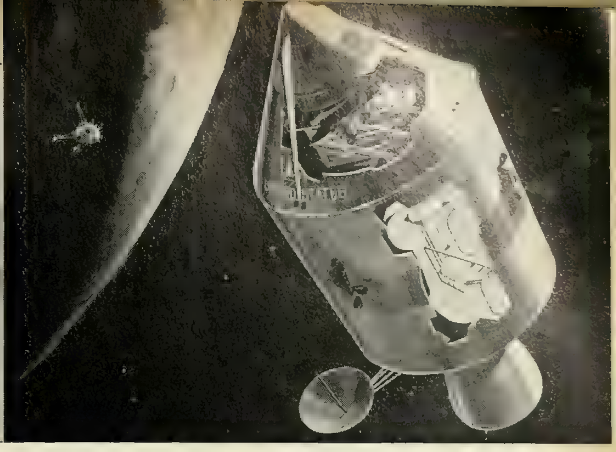

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Administration Funding Nod Awaited

Advanced Manned Missions office ready to go to pre-program definition of 6- to 12-man unit to be flown about 1972-74

FISCAL YEAR 1967 could be the year NASA begins planning for the next generation of manned space stations if the Administration gives the nod during current budget talks.

The uncertainty is believed to center around whether or not NASA's Advanced Manned Missions office will be instructed to proceed with pre-program definition activities on an orbital space station of some sort to come after the *Apollo* Applications (AA) program. Such a decision would answer Congressional critics—chiefly on the Senate Space Committee—who are irritated with the space agency's failure to make specific plans for the period after *Apollo's* benefits are squeezed dry.

In NASA's Advanced Manned Missions Office, much of the preliminary work on a 6- to 12-man station has been completed and the office says it is ready at any moment to go to pre-program definition of such a station. This would be the same kind of activity that has been going on in the *Apollo* Applications program.

The time generally considered for first flights of such a station range from 1972 to 1974. At this time, *Apollo* as a basic laboratory will have outlived its usefulness, and the need will be for a space station designed for specific missions.

The 6- to 12-man station of the *Manned Orbiting Research Laboratory (MORL)* type, perhaps not exactly like that outlined by Douglas, would appear to be best suited for those advanced missions that can be defined at this time. However, the office is continuing its investigation of all possible alternatives, so that it will be prepared for any decisions the Administration might make.

Another concept getting a great deal of attention is the use of the *Saturn* S-IVB stage as a space laboratory. Others being kept on back burners include the *Apollo* laboratory, a "brute force" *Saturn V* laboratory that would require no resupply for perhaps a year, and large orbiting laboratories.

- **New philosophy**—The perspective in which these efforts is viewed is different from that in the past, when configurations were looked at simply for the technological problems. Now the mission, whether it be scientific investigation or applications, will dictate the characterictics of the station.

The scientific community will be approached around the first of the year for lists of the "burning questions", as Earth-orbital studies director Morris Raffensberger put it, which must be answered in the various disciplines in a research laboratory in space. For the first time, experiments will be chosen for how well they may answer these questions, rather than having them emerge singly as experimenters put forth their own special interests.

The Manned Spacecraft Center in Houston will begin to take a larger role in handling contracts on space station work, with the completion of the Douglas *MORL* winding up Langley Research Center's responsibility on that contract.

Among the next steps NASA's Advanced Manned Missions Office will take will be to emphasize studies in these areas:

—The possibility of using the S-IVB stage as a research vehicle in space, perhaps initially as an unpressurized container, but ultimately as a pressurized laboratory.

—Continued studies of the requirements and implications on space station design the various uses would impose. This contrasts to former studies that emphasized the technology of constructing space stations, which is now pretty well understood.

—The degree and manner in which extravehicular assembly and maintenance activities can enhance the effectiveness and ease of preparing experiments requiring large apparatus.

—The concept of a "brute force" station—a look at minimizing the cost of logistics resupply of active space stations by either lengthening resupply periods and/or cutting down on the cost of resupply operations.

—Investigation of the implications and engineering considerations of rotating an entire space station, especially one for 6-12 men.

—Logistic studies stressing hypersonic and subsonic lifting bodies.

Funds available for advanced Earth orbital studies—excluding AA, appear to be about $4 million in the FY '66 budget. However, some funds remain uncommitted from FY '65, all of which will be spent.

Most of the decisions on actual contracts will be made in January and February, Raffensberger said, since at that time NASA will have completed its review of how to reapportion the current fiscal year funds in the light of completed Congressional actions, and will at the same time have a fair idea of what the next year's budget will look like.

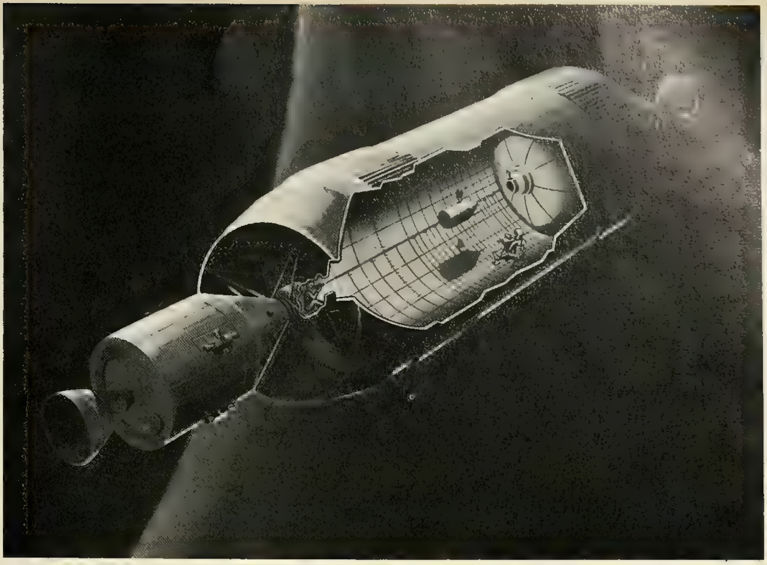
- **Artificial g**—While there has been no reason to believe that there will be a need for artificial gravity, Advanced Manned Missions Director Edward Z. Gray stressed the need to better understand the possible implications of artificial gravity on the convenience of operation of a space station.

A request for proposals will be issued from MSC on such a study in the near future, Gray indicated. The study will deal with the trade-offs in both operations and experiments on various space station sizes up to the maximum *Saturn V* payload for Earth orbit. Funds available for the study will be somewhat less than the $1.2 million in the current *MORL* contract, he indicated.

Other RFP's due out in the near future, some for FY 1965 money not yet expended, include a group in the category of definition of experimental programs in space operations technologies/subsystems estimated at about $750,000. One RFP, to come from Marshall Space Flight Center, will deal with extravehicular engineering. The Manned Spacecraft Center is preparing an RFP for a space power system. The Atomic Energy Commission is taking over one task in this group—study of a manual manipulator.

Preparation in the Office of Space Sciences and Applications is under way on a program-definition study of a manned Earth orbital experimental program in astronomy. Two other studies in the $500,000 fund for Earth orbital space sciences experiments program definition include a study of an orbital radio astronomy observatory, for which negotiations are under way, and on the feasibility of observing the Sun by manned orbital solar telescope.

While one study has been let on



SATURN S-IVB stage is being investigated for use as a vacuum laboratory in 1968-69, and possibly as a pressurized laboratory in conjunction with a support module or MORL-type module for 1970-75.

atmospheric sciences and technology, an in-house review is under way tagged at about $300,000.

Three or four studies are yet to be placed in a group on communications experiments and navigation/traffic control experiments program definition as well.

A number of studies in the Earth resources survey and inventory experimental program definition area will be conducted by the Office of Space Sciences and Applications (OSSA) through the various other interested agencies, such as the Department of Agriculture, Commerce's Geological Survey, the Navy's Oceanography Office and the Army Map Service.

While the choice of experiments for the manned orbiting research station will define the exact configuration, some general conclusions about the kind of station needed have been reached.

According to Raffensberger, it appears that the 6- to 12-man station will best fulfill the next generation of missions. There seems to be no present advantage in going above 12 men, since to be useful, their activities would have to become very heterogeneous. For numbers more than 12, it might be more economical to launch two spaceships, he suggested.

Thus the working number of men is 9, although the station may or may not be the *MORL*. However, the advanced manned missions group is also preparing alternatives around this number to cover any reasonable contingency for executive decision.

- **Early goals**—Among the immediate goals of early Earth orbital missions will be operations support. This will include such tasks as mission simulation and checkout, and utilization of early concepts for future orbital and large space stations. Advanced techniques and procedures will also be tested, such as checkout of portions of future missions, including rendezvous and docking and emergency procedures.

Extravehicular activities in the early missions would support such things as setting up a telescope, communications tasks and testing procedures for orbital launchings.

Advanced subsystems also would be tested, including electric power systems, waste-management and life-support systems.

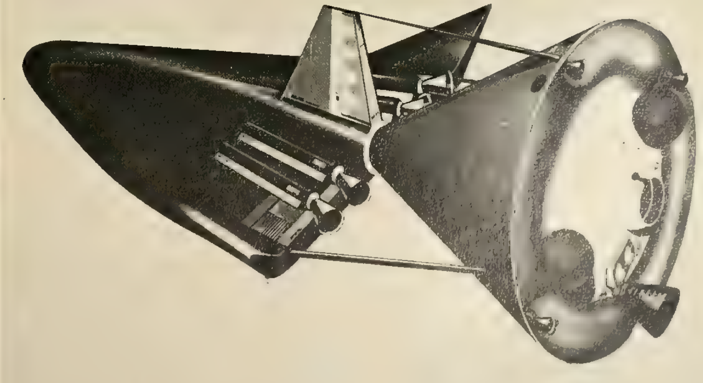
Among the concepts that must be considered a space station plan, although it falls partly in the *Apollo* Applications category, is the *Apollo* laboratory module. Many of the goals could be accomplished through this.

Chances for an early *Apollo* lab station have been lessened however, because it competes in size with the Air Force's *Manned Orbiting Laboratory (MOL)*. Studied by Boeing, the *Apollo* laboratory would use the AA Command and Service Modules (C/-SM) and a laboratory that would replace the Lunar Excursion Module in the adapter area.

The vehicle would be launched into a 200-n.-mi. Earth orbit by a *Saturn IB*, and provide a module with 1,300 cu. ft. In the passive concept, *Apollo* subsystems could supply the laboratory. Lifetime would be about one year, with 30-day resupply.

According to the Boeing concept, the basic module would weigh slightly more than 6,800 lbs., including the structure itself, the electrical subsystem, two *Apollo* suit umbilicals, a data subsystem, an emergency subsystem for

NINE-MAN FERRY vehicle looks like the optimum size for an advanced logistics vehicle at present. NASA also is interested in lifting bodies that would not require large deployments of recovery forces.



atmosphere, and equipment for atmosphere circulation.

With approximately 11,500 lbs. available for LEM replacement payloads, this would allow a margin of more than 3,600 lbs. if the typical experiment package weighs just over 1,000 lbs.

The *Apollo* laboratory also could be fitted with active subsystems of its own, but this possibility appears to be even more remote.

- **S-IVB stage**—Yet another concept being actively studied by Marshall Space Flight Center is use of the *Saturn* S-IVB stage, after the fuel is spent, as an Earth orbital laboratory.

An unpressurized S-IVB could be used for extravehicular experiments, development of hardware for future space stations, and for training procedures in operations and maintenance and emergency procedures by astronauts living in the *Apollo* C/SM. The S-IVB shell would provide micrometeoroid protection and radiation shielding, as well as a confining chamber for the crew.

The vehicle, after fuel is spent, could offer 10,000 cu. ft. of space. It would provide approximately 6,500 lbs. of payload in low Earth orbit, and could be launched into a circular, 200-n.-mi. orbit for better than 45 days.

In the *Saturn V* era, NASA officials say it could theoretically be adapted for pressurized use up to 14 psi, supported by a multi-mission module, or perhaps even with an *MORL*. For some uses, two could be strapped together. Some of these configurations could be used in the "brute force" concept.

While the S-IVB is not now an orbital vehicle, this would offer no serious difficulty, NASA officials said. However, the main problems, now being investigated by Marshall and by the Manned Spacecraft Center, are concerned with the inherent capabilities of the structure, whether the thermal balance is adequate for manned occupation, and whether proper stability can be achieved.

- **Modular multi-purpose space station**—Another study, just completed by Lockheed-California Co. as an outgrowth of the *Large Orbiting Research Laboratory (LORL)* contract, is on the concept of a family of space stations using a modular approach.

Six missions were considered in the study; combinations of from 3 to 36 men from periods from 45 days to 10 years. The four basic space station types fulfilling these requirements would include a one-compartment laboratory or multi-mission module, a series of two-compartment laboratories, an interim space station with six compartments, and an operational space station consisting of a central hub and three radial modules of six compartments each.

While no further work will be done on the *LORL* at this time, Raffensberger said NASA is stressing development of all subsystems on a modular approach if the penalties are not too high, so that they could be put together if needed.

- **MORL concept**—The *MORL*, as Douglas currently envisions it, would have a laboratory module with two independently pressurized compartments connected by an airlock.

In the larger compartment there would be—on decks or stories—a control deck from which laboratory operations and a major portion of the experiment program would be conducted, and an internal centrifuge for crew member therapy, physical condition testing, and re-entry simulation. Still below this level would be the flight crew quarters, including sleeping, eating, recreation, hygiene, and liquids laboratory facilities.

The smaller compartment would be a hanger/test area. Uses would include logistics maintenance, cargo transfer, experimentation, satellite checkout and flight crew habitation in case of emergency.

The nine-man vehicle could be launched unmanned into a low-inclination, near-Earth orbit by a *Saturn IB*. A ferry-resupply logistics system consisting of an *Apollo* Command Module, a cargo module and an S-IB stage would be launched immediately to bring the initial crew. Similar vehicles would be launched later for resupply.

The laboratory module and an *Apollo* Command Module could be launched with men on a two-stage *Saturn V* into high-inclination, near-Earth orbits. Manned launch also would be used for synchronous and lunar orbits, which also would require the *Apollo* Service Module and use of the three-stage *Saturn V*.

A laboratory with a volume of approximately 4,500 cu. ft. and 6 kw average power drain will be required for a crew of nine, the *MORL* study said. The initial crew size recommended is six, and since extensive logistics support will be required, crew size should remain as small as practical until experience has been gained and operational logistics capability has evolved.

- **Access ports**—There would be two means of access to the Douglas *MORL*, one through the hangar/test area and one through the aft airlock. The hangar/test area, separated from the forward pressure compartment by an inverse-pressure bulkhead, would act as a transfer airlock for personnel moving from the logistics spacecraft into the main portion of the laboratory, the study says.

If the *Gemini* should be used as the logistics spacecraft, it could be drawn into the hangar for maintenance activities that require external access. With the *Gemini* spacecraft docked, approximately 1,600 cu. ft. of volume would be available in the hangar/test area.

The control deck would be divided into four test areas by consoles and partitions: one for operations and command and control of the station, one for experimental control, and two for experiment procedures.

- **Experiment arrangements** — Design features that would be specifically incorporated for experiments include the equipment airlocks, which would be used for environmental sampling, mounting of multispectral cameras, and specimen exposures.

Besides this, a number of experiments would be unsuitable for mounting from within the laboratory, and would be mounted in the cargo compartment of the logistics spacecraft.

The hangar/test area could thus be arranged to permit the docking of a multi-mission module to it or to the side of the laboratory, the Douglas study suggests. Free access into the module could be obtained through either the side or front dock position, permitting better use of special-purpose devices such as the telescope module and biological animal farm.

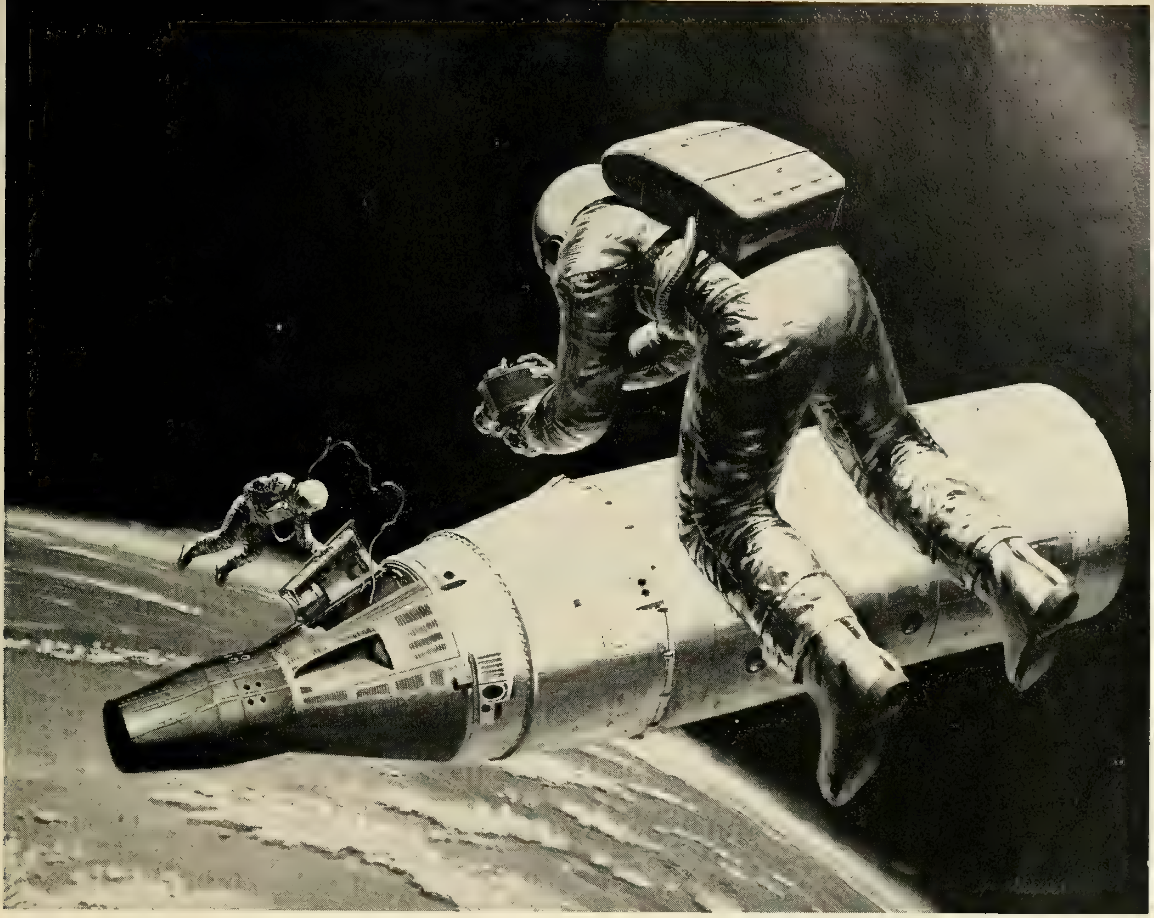
Certain types of experiments will have great impact on the design of the *MORL*. Two of these, biological studies and astronomical observations, could best be implemented through use of separate experimental modules, brought up by the logistics vehicle.

An animal laboratory, for instance, requires precautions to guard against contamination by toxic materials or viral infections from the animals into the manned portions of the laboratory. By placing it in a separate self-contained laboratory, the animals would be separated from the crew by buffer volumes at negative differential pressures, and by airlocks.

Astronomical laboratories, with their demands on the stability and control of the laboratory and the operational volume necessary for placement and alignment of reflecting surfaces, might also best be handled in separate cargo modules, Douglas suggests.

- **Subsystems**—For missions longer than 100 days, an environmental-control and life-support system with a closed water-management system would be needed, as would be a closed oxygen system using the Bosch method of regenerating oxygen from carbon dioxide, and waste-management, temperature control and ventilation, and liquid cooling systems.

Life support for the two compartments—laboratory and hangar—would be separate and redundant with special filtering for experimental areas.



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Power sources for consideration, Douglas suggests, are solar cell/battery isotope Brayton cycle, and nuclear reactor/thermoelectric. While the former would be used initially, a nuclear or isotope system would be desirable as early as possible.

The Douglas concept does include provisions for the future for near-continuous artificial gravity to provide simulation of lunar and Martian gravity for experimentation, investigation of a convenience level of artificial gravity, and insurance in case men cannot adapt to weightlessness for a long period.

The initial laboratory deployment should not include this capability, Douglas says, but the second one should. The method used would be to deploy the laboratory from the S-IVB stage on a system of short struts and eight cables, rotated by torque supplied from a separate propulsion/reaction control system mounted on the S-IVB. This would provide up to one-g force fields at the control room floor on a variable-radius arm up to 40 ft. long.

- **Logistics system** — Douglas recommendations for a logistics system are based upon the company's calculations that approximately 40,000 lbs. of supplies will be required each year for a six-man crew.

Douglas sees two contenders for a logistics vehicle in the *Titan III-C-Gemini* and *Saturn IB-Apollo,* either of which would be capable of yielding between 50,000 and 60,000 lbs. of cargo capacity with 12 men rotated per year.

However, Douglas says it favors the *Saturn IB-Apollo,* since it is better designed to be suitable for long-duration storage in the space environment. Maintenance is done from the spacecraft interior rather than the outside, as with the *Gemini,* the *Saturn IB-Apollo* has double the passenger capacity per flight, and greater safety because fewer launches would be required.

Douglas suggests modifying the *Apollo* with the addition of a service pack and cargo module, which could be separated and rotated by mechanical linkages to parking positions along the *MORL* hangar/test area exterior.

- **Other logistic vehicles**—Two contracts are now under way on reusable transports, including one on incremental systems development by Lockheed and a comparative study of horizontal take-off/vertical takeoff by Martin. There is more emphasis on nonreusable vehicles, however, and a great interest in lifting bodies since they would not require the recovery forces needed for ballistic re-entry.

North American Aviation recently reported on a ballistic orbital support vehicle that could resupply a variety of orbital research stations operating at altitudes from 200 to 300 n. mi. This vehicle theoretically would be capable of six months' orbital storage, no EVA would be required for transfer, and the entry lift to drag ratio would be between 0.25 and 0.50.

NAA's study indicated that a nine-man ballistic logistics spacecraft was optimum for the space station NASA postulated, and that the *Saturn IB* could launch such a vehicle for inclinations up to 55°.

For either polar or synchronous orbital space stations, however, supply vehicles would require the *Saturn V.*

NAA also points out, however, that if the U.S. space station program does not attain the pace or size predicted, significant savings could be realized by using a modified *Apollo* Comand Module with a new cargo module capable of carrying six men.

The NAA configuration, which would carry two rows of crew members with four men in the upper, five in the back, would be 168 in. in diameter, have a 184-in. heat shield radius and a sharp heat shield intersection. Apex cone angle would be 55°. ■

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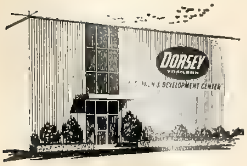

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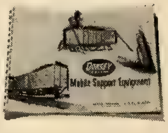

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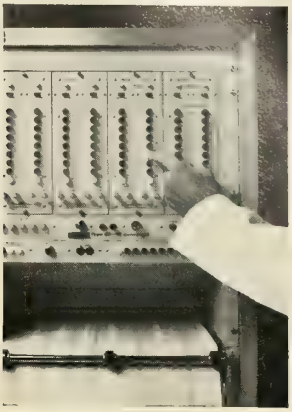

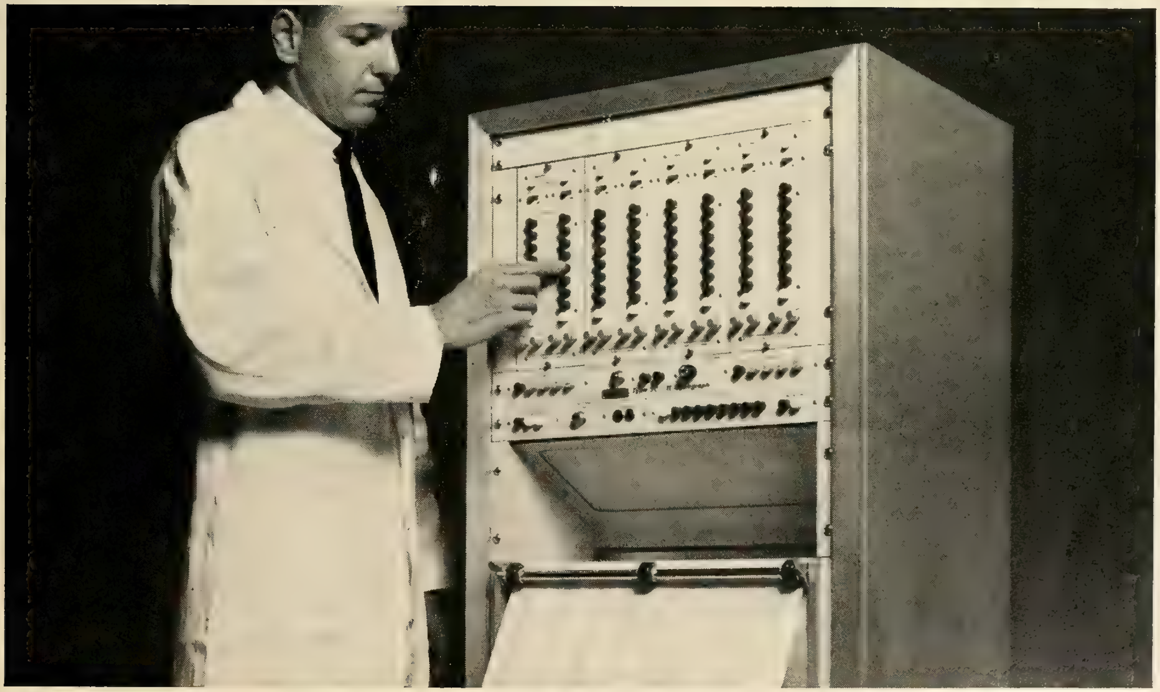

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National-goal emphasis comparable to that given Apollo is more vital than fund increases; LEM truck superseded

ALTHOUGH THE Lunar Excursion Module truck, conceived as a means to supply an *Apollo*-derived Moon base, is now dying, a non-stop Earth-to-Moon bus is taking its place.

This is a new example of NASA's unofficial but driving effort to set the stage for increased efficiency in logistics supply of man in interplanetary space and manned interplanetary exploration in the 1970's.

Achieving the manned Venus fly-by and manned Mars landing is not a matter of money but rather one of focus, a NASA official said.

If it gives them the same emphasis applied to the *Apollo* program, and maintains level funding, the United States can accomplish such missions sometime during the 1980's. They would involve new spacecraft, an upgraded *Saturn* booster, and possibly a nuclear stage.

Stating these conclusions to MISSILES AND ROCKETS, Edward Z. Gray, NASA's Advanced Manned Missions Program Director, said, "I don't believe we have to multiply our investment in space to make the Mars mission feasible. He noted, "We're in the hardware stage for Mars/Venus already in terms of evolution of *Saturn V;* if we get charged in the '70's with planning a manned mission to the planets, we will use some form of *Apollo.*"

LUNAR EXPLORATION

Turning to lunar exploration, Gray stated, "I don't think the LEM truck will ever happen." He was referring to the proposed 6,000 to 7,000-lb. palletized logistics vehicle made of a LEM without ascent stage and launched to the lunar surface by an *Apollo* orbiter. He said a better approach would be a direct flight employing a *Saturn*, which could soft-land about 30,000 lbs. on the lunar surface, as proposed with LESA (Lunar Exploration System for *Apollo*, weighing about 25,000 pounds)."

With respect to lunar surface vehicles, he said, "We have no interest in an unmanned unit." He described several critical areas needing work before man can have a vehicle able to wheel him around the lunar surface: power transmission units, bearings, lubricants and thermal radiators. Laboratory work was started on these problems in Fiscal '65, and is extended into Fiscal '66.

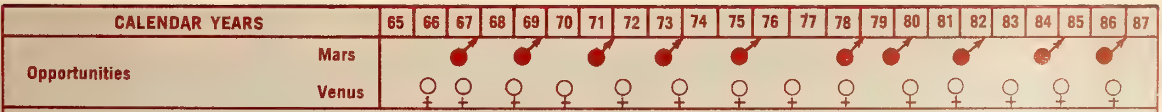
"We are studying how big the vehicle is to be," he said, "and how we can develop growth potential if the scope (of the lunar program) is extended." The work is essentially a parametric study since particular vehicles are not now under intensive examination, but common technical problems are. Nevertheless, the size of the lunar vehicle built for the '70's will depend on the amount of money in the Fiscal '67 budget for further studies and development work, according to Gray.

- **Lunar mobility**—The Lunar Scientific Survey Module (LSSM) is planned as part of the *Apollo* Applications (AA) program. "Therefore, we are planning to go into project definition on a lunar mobility system in Fiscal 1967," said Philip E. Culbertson, Lunar Mission Studies Director. In a detailed discussion of LSSM, he agreed with Gray that the nature of the system is still being weighed. "We are in the process of finding out what the requirements for a lunar exploration program should be."

Inputs from the scientific community as well as from NASA in-house committees result in "our requirements, that is, the specific mission plans from which will fall out specific requirements for mobility," he said. These include vehicle range, power to carry support and scientific exploration equipment, and weight and volume available.

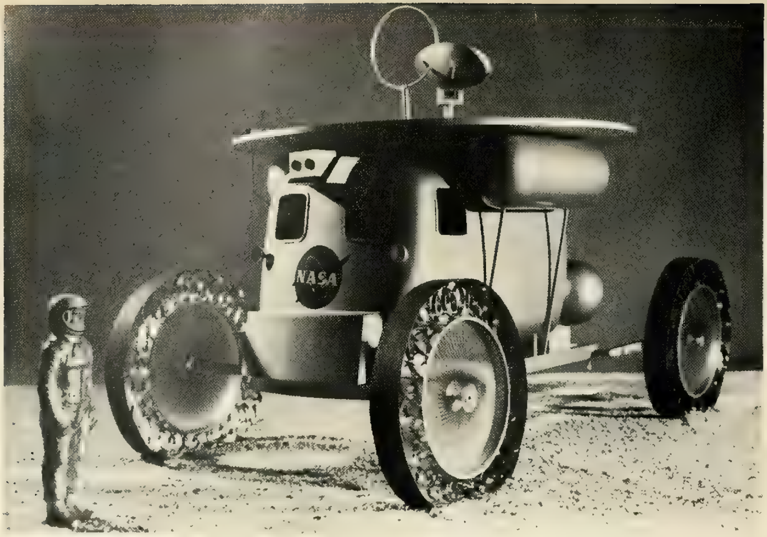
"We're talking about one-day missions with a radius of action of 8-10 km.

OPPORTUNITIES for manned missions to Mars and Venus.



PROMISING MANNED MISSIONS

TYPE MISSION	PLANET	NOMINAL DURATION (DAYS)
Flyby	MARS	500-700
	VENUS	350-380
	MARS - VENUS	450-600
	VENUS - MARS - VENUS	700
Orbiting	MARS	350-500
	VENUS	360-400
Landing	MARS	350-900
	VENUS (?)	360-400
Flyby-Landing	MARS LANDING - VENUS FLYBY	500-550
	VENUS FLYBY - MARS LANDING	500-550



CONFIGURATION of Mobile Laboratory (MOLAB) developed by Bendix Corp.

from the LEM shelter," said Culbertson. The vehicle was seen as nominally holding one man, with a payload capability of 300 (Earth) pounds. It would have "considerable mobility" for negotiating rough lunar areas, but would not be designed for the most severe conditions. A typical mission would last about six hours, and "there would be a lot of stop and go."

On return to the LEM base, the module would be recharged for the next day's operation. However, it is "too early to say what the primary fuel system will be," said Culbertson.

Since no environmental enclosure is planned for the first LSSM, the astronaut-driver will have to wear his pressure suit continuously. He will implant some equipment in the lunar surface and employ other equipment to test it.

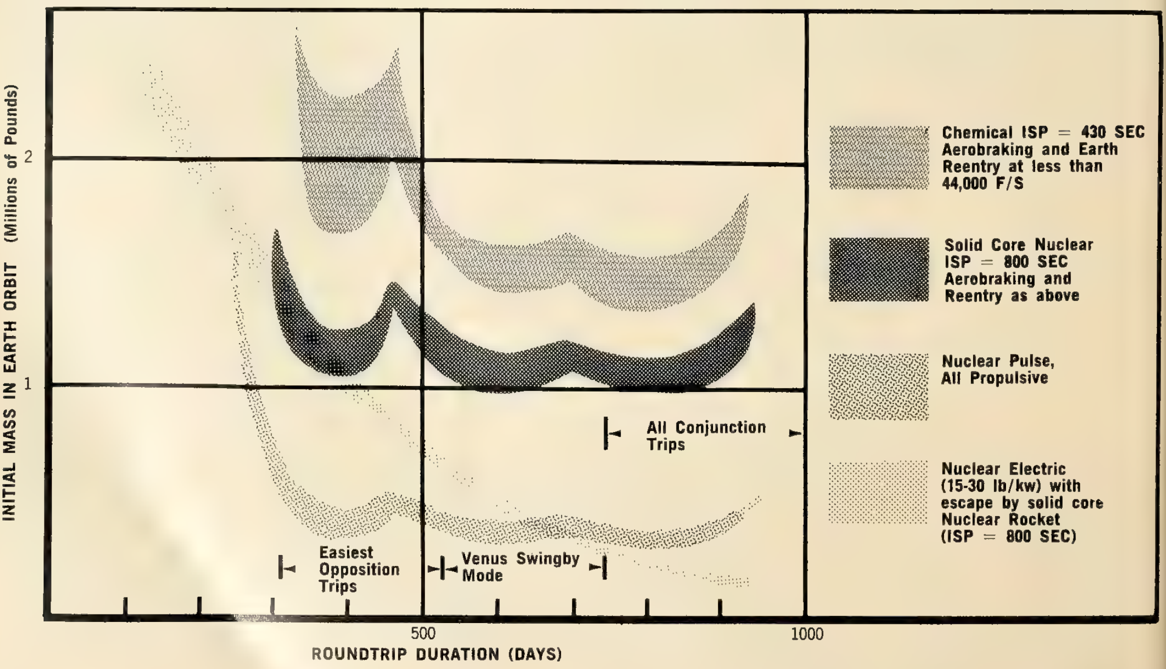
- **Communications via Earth?**—The present concept calls for the lunar explorer riding in LSSM to be able to communicate continuously with LEM and therefore with Earth. A communication problem is brought up when the astronaut is out of line-of-sight of LEM. This could be overcome if earlier he were to plant a transponder able to "see" LEM and LSSM at all times. What appears to be more economical is "for the astronaut to communicate with LEM via an Earth relay," according to Culbertson.

Asked if the 300 lbs. of payload could be used to transport a second man on the LSSM, Culbertson agreed it could, but "only if a serious requirement existed for the second man." He said the feeling is the payload should be strictly instruments.

Not yet determined is what the vehicle speed should be or what measure should be used to prescribe hill-climbing capability. Power will be electric, with each wheel individually driven for mobility and reliability. Present thought calls for "soft metallic wheels—but we are not sure if there should be a total of four or six, or even eight," said Culbertson. He indicated, however, that the eight-wheeled vehicle has an uphill fight to compete with four- and six-wheeled vehicle concepts.

Under the AA program, the LEM shelter would descend to the lunar surface in advance of the astronauts. It is proposed that LSSM ride piggy-back on the shelter. In this way, one descent vehicle would accomplish two objec-

EARTH-ORBIT mass and trip duration for manned Mars landing.



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TD 1337

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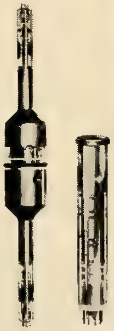

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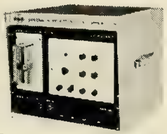

ED 6025

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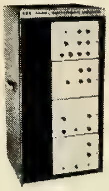
Completely transistorized, the 6025 is designed to provide video signals by scanning 35 mm slides. Various scanning formats can be obtained by selecting the appropriate plug-in module.



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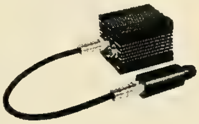
Universal Scan Converter

This completely solid state system is capable of converting between various scan formats. Typical conversions include: PPI to TV, slow scan to TV, character writing input to TV output simply by selecting proper module. The system can be modified to any specific customer requirement. It is designed around the TD 1372 dual gun tube.

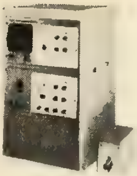


ED 6038

Transistorized Environmental TV Camera

Its miniature and rugged design provides for high detail, stable pictures under the severest vibration, shock and noise conditions of missile and space vehicle environments. The system was designed around the GEC ½" Hybrid Vidicon.

ED 6030



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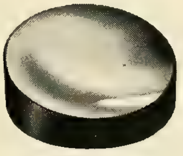

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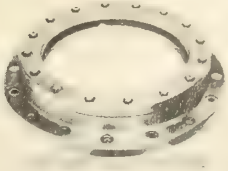

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tives and could be checked out remotely before the astronauts are launched.

NASA is also "seriously considering" a flying vehicle system that would enable an astronaut to explore craters and other severe terrain; it would furthermore allow for faster coverage of the lunar surface. However, a surface vehicle is considered better for missions involving frequent stops and close examinations of many points along the way.

Culbertson said that the flying system would probably not be the first of the systems used for ground exploration of the Moon, but he was disinclined to "bet my last dollar on this being so."

Bell Aerosystems Co. is the only NASA contractor looking into the flying system for Culbertson's office. The company's concept would have essentially the same capabilities as the surface vehicle—300-lb. payload plus an operator. Other ideas involve using smaller systems, but not the familiar rocket backpack because its payload capability is too small.

The Bell vehicle would hover and translate by means of deflected rocket jets. It, too, would be designed for mounting on the side of the LEM shelter.

- **Post-AA program studies**—No approved post-*Apollo* Applications program exists now with respect to the lunar program. Yet, NASA will engage in a number of studies in Fiscal '66 to enlarge the scope of the lunar surface vehicle, particularly with a view to increasing mobility, range, power, crew, radius of action, dwell times, and scientific payload capacity.

The vehicle will probably be environmentally enclosed for long traverses, estimated as having a radius of from 50-200 km.

"We have pretty strong guidelines from the scientific community telling us their desires with respect to lunar exploration," said Culbertson. Many of these were expressed this past July at a NASA conference at Woods Hole, Mass., and attended largely by non-NASA scientists. NASA expects to publish the proceedings soon.

Whatever routes of scientific inquiry are followed, they will all be directed "to take maximum advantage of the launch capabilities of *Saturn V* and *Apollo* systems," Culbertson stressed. These will be exploited as long as it is efficient to do so.

Yet, if the lunar program continues much past 1970-2, then the present *Apollo* equipment "will have to be supplemented to support extended lunar exploration," Culbertson said. He noted that studies are exploring use of a LEM descent vehicle as a crew-carrying member only and the possibility of its landing three or four astronauts.

- **Direct flight vs LOR**—Confirming that further studies of the LEM truck "are out," Culbertson said Fiscal 1966 studies will include comparisons of delivering men or material to the Moon by direct flight or lunar orbit rendezvous (LOR). These studies would consider using minimum extensions of *Apollo* hardware, but all would use the *Saturn V* launch vehicle.
- **Funding**—Fiscal '66 funding for lunar studies of an advanced nature will be a little under $2 million. The same amount of money is expected for these purposes for Fiscal '67, until a program is approved.

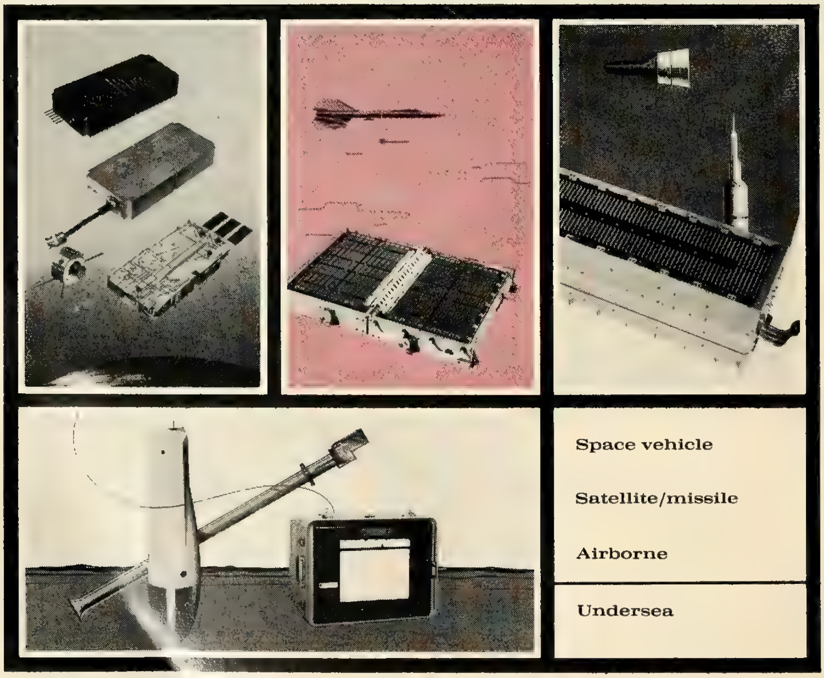
The lead-time needed to develop a significant new system is about four to eight years, depending on the system's complexity. Therefore, for post-AA programs, "approval will be needed within the next two to three years," said Culbertson.

On the basis of expressed desires of influential engineers and scientists, lunar exploration programs would have the following objectives:

—Obtain and analyze information from the Moon to determine its environment, composition and gross body properties.

—Establish observatories and laboratories on the Moon.

—Learn how to use lunar resources



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PLANETARY EXPLORATION

Dr. Franklin Dixon, NASA's director of manned planetary missions studies, foresees the first manned planetary expedition going either to Mars or Venus, but the first planetary landing occurring on Mars because of its less hostile environment. Mars, moreover, appears to be more likely to support extraterrestrial life and is therefore more interesting to scientists.

Dixon emphasizes that although the weight of past studies have been devoted to Mars, the Venus manned mission is by no means excluded. Although a Venus landing would be more difficult, capture missions with orbits around Venus "should be easily achieved using the propulsion systems and spacecraft technology required for a Mars landing."

Verifying Dixon's point, William Huber, Marshall Space Flight Center (MSFC) official, said that manned Venus fly-bys are a major study effort at MSFC's Advanced Systems Office in the current fiscal year. In an interview with M/R's companion publication, *Missile/Space Daily,* last month, Huber said such a fly-by could be made in the 1975-77 period, when the relative positions of Earth and Venus will be favorable, but that if it slips beyond 1977, there is no point in going since the flight would intrude into the favored time for a Mars landing.

- **Venus studies**—Marshall studies for the Venus fly-by involve both refueling in orbit and orbital assembly techniques. For the first, tankers would be orbited to provide propellant to the planetary spacecraft. In the second, the already-fueled stages would be joined together. Huber believed that three *Saturn V*'s could easily do the job. He noted that developments are still needed to get a life support system able to operate for a year and a new living module for the crew. He said the concept would also involve modifying the S-II stage by reducing the number of J-2 engines from five to two while retaining the same amount of propellant.

NASA's office of Manned Planetary Mission Studies will spend about $1.6 million this fiscal year for studies chiefly of Mars and Venus missions. Work will be managed by Manned Spacecraft Center, Houston, Marshall Space Flight Center, Huntsville, Ala., and NASA Headquarters.

- **Study money to increase**—Money for continued studies in Fiscal 1967 is expected to rise above current expenditures, reflecting increasing interest in advanced manned space missions. This fact is even more apparent when judged

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from past funding levels; in Fiscal 1964, $1.3 million were spent on a total of six studies, the last of which was completed within the past few weeks. In Fiscal 1965, no money was supplied because earlier work was still in progress and there were "more promising studies of more immediate interest" in other NASA offices, according to a NASA official.

● **Economical fly-bys**—The space hardware and technology the nation is using for the *Apollo* mission to the Moon would be sufficient, granted some extrapolations, to send fly-bys to Mars and Venus. This is affirmed by NASA planetary experts interviewed by M/R. They also agree that existing technologies and systems would be inefficient and ineffective for stop-over missions, expensive, and would give no latitude for growth into more ambitious space projects.

A recently completed North American Aviation, Inc., study of a manned Mars/Venus fly-by mission concluded that 57% of the *Apollo* spacecraft system was directly applicable without major modification. Changes would occur chiefly in three areas: 1) living quarters and laboratory space; 2) life-support system (since long-time operation and onboard maintenance would be required); 3) power system (since an auxiliary unit would be needed, possibly based on radioisotope energy).

The Mars fly-by mission has low energy requirements and is relatively insensitive to the year of opposition insofar as changes in these requirements are concerned. Dixon notes, however, "problems are introduced by the mission duration (700 days) and the fact that the trajectory carries the spacecraft beyond the orbit of Mars, where the asteroid belt debris may be a hazard." Mass in Earth orbit for this mission would vary from 1.0 to 1.3 million pounds.

Dixon expects that small probes will be sent into planetary atmospheres by Mars/Venus fly-bys, some of the probes perhaps achieving an atmospheric profile down to planet impact. Continuing, he said, "Our intention is to examine the fly-bys in sufficient detail to prove feasibility from a systems point of view, so enough information is available to assess mission capability from a scientific point of view."

Contracts for fly-by studies are expected to be let within the next few months, according to Dixon. "We have to examine injection propulsion capabilities (from Earth-orbit) and look at the total mission operation and support required." He said there is need to define system requirements for a manned planetary vehicle, using nuclear electric propulsion and thermionic conversion.

● **Mars landing timetable**—Paralleling Gray's views, Dixon remarked "as personal opinion," that with a major national commitment, "we could do the manned Mars landing mission by the late 1970's or early 1980's—in fact, we could do it as a logical progression step, based on technological evolution, by the mid-1980's."

Dixon said it "makes sense" to look at the 1982-85 time period because then a fast landing mission could be made to Mars. This would be an opposition-class trip, where the spacecraft would arrive and depart Mars within a span of a few days near the time of opposition. An opposition of Mars, occurring when the Earth passes between Mars and the Sun, takes place about every 25 months. The planets are closest to each other at that time, but, due to the ecentricity of the Mars orbit, this distance can vary from 34 million miles, during a favorable opposition, as in 1971, to as far as 64 million miles during an unfavorable period such as that of 1980.

"The best operational capability would be with a post-*Saturn* launch vehicle and nuclear propulsion," said Dixon. He said the combination could reduce the mass in orbit for the manned Mars mission by a factor of two or more.

If a single booster could put three million pounds into Earth-orbit, there probably would be no need for extended Earth-orbital operations such as spacecraft assembly and rendezvous. With such a weight in orbit, the following missions could probably be accomplished, according to Dixon:

—Conjunction-class trips to Mars using chemical propulsion. (Earth and Mars are in conjunction when the distance between them is a maximum; separation distance can be as much as 250 million miles.) For such a trip, the spacecraft would arrive at Mars after one opposition date and depart before the next. These are long-duration missions taking on the order of 750-950 days with stay-times on the planet up to 550 days. This class of missions is described as having low propulsive energy requirements and entry speeds, a mass in Earth-orbit appreciably less than the opposition-class of "fast" trips (350-500 days) and unlike the "fast" trips because energy requirements vary only slightly across the synodic cycle.

—Opposition-class trips using nuclear propulsion.

—Venus swing-bys using chemical or nuclear propulsion.

• **Total-mission craft**—In terms of studies, NASA will be looking at total-mission spacecraft, able to perform the manned Mars landing and/or Venus-capture, based on chemical and/or nuclear propulsion. The agency would be particularly interested in a spacecraft that could do both jobs. Dixon says he is authorized to look into the feasibility of such a spacecraft.

He pointed out that the Mars landing would probably use the Mars Excursion Module (MEM). But for the Venus-capture mission, more propulsion would be needed than for the Mars mission. He therefore suggests looking into tradeoffs: take out the MEM, perhaps, and add a capture and departure capability for orbiting Venus. "In other words, take the common elements of both systems," and provide what is lacking for the duplex mission.

• **Venus swing-by**—Another aspect of the study will be to look into alternate mission modes. OART, for example, demonstrated several years ago that a swing around Venus—that is, a gravity assist from the planet—could alter the trajectory and reduce the energy requirements for a trip to or from Mars. This information came out of a TRW Systems Group (then Space Technology Laboratories) study. In turn, this study was in part based on theoretical work done by Crocco in Italy in the late 1950's.

"We can use the swing-by even in unfavorable times," said Dixon. "Therefore we can send fast missions, and follow up by the slower ones," to correspond with the opportunities. ■

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By FRANK S. WYLE, President, Wyle Laboratories

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Fluorine Upper Stage Now in Prospect

Many studies of other new vehicle concepts indicate dearth of useful knowledge; accent on post-Saturn V research is criticized

A HIGH-ENERGY upper stage appears to be the only new NASA launch vehicle headed toward hardware development in the next two years.

Otherwise, the hundreds of launch-vehicle studies conducted by NASA, both in-house and under contract over the past several years, are serving to point out areas in which there is too little information, too little effort and too little hard research.

The planetary kick stage, which would be fueled by fluorine, is currently in the Phase IA preliminary design, but space agency officials hope to move into systems definition with Fiscal Year 1967 money. Hardware development would then probably be initiated in FY '68.

The fluorine stage would be used as the final booster for unmanned flights to the Sun, Venus, Jupiter and elsewhere.

In the manned area, A. Dan Schyner, acting chief of launch vehicle studies in the Advanced Manned Missions Program Office of the Office of Manned Space Flight, says too much time has been spent on the *Saturn V*-and-beyond categories at the expense of vehicles for more immediate use. For instance, there is a need for more definitive studies into the uprating and improvement of the *Saturn IB.*

In addition to the concepts of strap-on solids and uprated engines, the whole area of high floxing of the propellants needs work. These are flox concentrations in the 60 to 70% area. The major problem in the *IB* class is the exhaust dispersion after launch. This involves handling and other changes in the launch area.

The impact of such high floxing on the engine components has to be studied. The impetus here is the consideration being given to boosting the *IB* with solid so that floxed propellant is not used until the vehicle reaches altitude. This combination radically increases the performance of the *IB*.

● **Strap-ons gain favor**—The most likely route to uprating the *Saturn IB* is the solid motor strap-on—the zero-stage concept currently successful on the *Titan III-C*.

The basic *IB* is designed to put about 36,000 lbs. into a 100-n.mi. orbit. Using a 120-in.-dia. solid either as boost-assists or as strap-ons would approximately double the *IB* performance ability. A combination of eight *Minuteman* first-stage motors would reach a slightly lower figure.

The Saturn V can put 250,000 lbs. in orbit, and use of 120-in. or larger solids as boost-assists could increase this payload ability by 25 to 50%. Studies also cover larger-diameter solids for these jobs.

Performance can also be increased by utilization of an improved upper-stage engine. One approach is an extension of conventional bell-nozzle rockets designed to operate at higher combustion chamber pressures. Other approaches involve unconventional chamber and nozzle configurations such as toroidal or annular combustion chambers combined with an aerodynamic spike nozzle.

Dr. Wernher von Braun, director of the Marshall Space Flight Center, says the advent of improved upper-stage engines introduces a fascinating possibility—the use of the second and third stages of the *Saturn V*, without the booster, as a launch vehicle.

This two-stage configuration could be used for launchings requiring performance in the big range between the present *Saturn IB* and the *Saturn V*. The concept itself is under study as well as investigations to the launch feasibility from the *Saturn V* complex at Cape Kennedy.

● **Facility effects neglected** — Although studies have focused on the

CHART INDICATES by general area the subjects of studies conducted during the past several years of future needs.

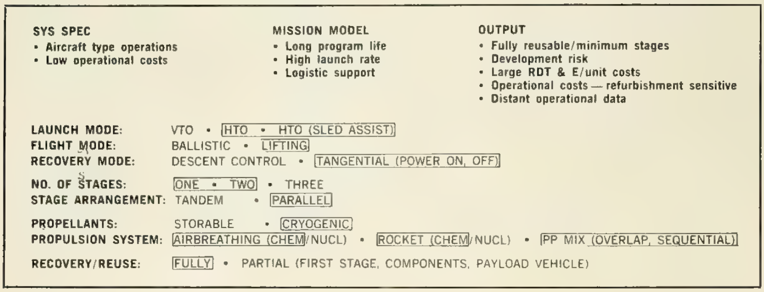
GENERAL CATEGORIES < Increased Size / Increased Efficiency

	FIRST STAGE	SECOND STAGE	THIRD STAGE
Propulsion System & Propellants	• UPRATED F-1 • TOROIDAL F-1 • ADDITIONAL ENGINES • FLOX	• UPRATED J-2 • TOROIDAL J-2 • ADDITIONAL ENGINES • ADVANCED ENGINE • FLOX	• UPRATED J-2 • TOROIDAL J-2 • ADVANCED ENGINE • FLOX
Vehicle Stage	• INCREASED LENGTH (PROPELLANT LOADING) • BOOST—ASSIST UNITS (SOLID OR LIQUID) • ZERO STAGE • NEW SOLID STAGE • REDUCED INERT WEIGHTS	• INCREASED LENGTH (PROPELLANT LOADING) • REDUCED INERT WEIGHTS	• INCREASED LENGTH (PROPELLANT LOADING) • REDUCED INERT WEIGHTS

vehicles themselves, Schyner finds a lack of good information on launch and manufacturing facilities. Most major innovations in these vehicles would require various changes in the manufacturing, handling, shipping and check-out at the launch sites.

Institution of changes designed to increase performance or effectiveness of a vehicle usually ignores facilities, and Schyner says this will have to be corrected. There are also facilities considerations with the intorduction of operational nuclear upper stages. These will probably come before any major improvements in the basic vehicles, and the facilities changes will be facts of life that must be figured into current studies on future vehicles.

There are cross-relationships among the studies themselves. The act of uprating or improving one engine on one stage might result in having the stage rendered incompatible with the original vehicle.


SYS SPEC
- Aircraft type operations
- Low operational costs

MISSION MODEL
- Long program life
- High launch rate
- Logistic support

OUTPUT
- Fully reusable/minimum stages
- Development risk
- Large RDT & E/unit costs
- Operational costs — refurbishment sensitive
- Distant operational data

LAUNCH MODE: VTO • HTO • HTO (SLED ASSIST)
FLIGHT MODE: BALLISTIC • LIFTING
RECOVERY MODE: DESCENT CONTROL • TANGENTIAL (POWER ON, OFF)

NO. OF STAGES: ONE • TWO • THREE
STAGE ARRANGEMENT: TANDEM • PARALLEL

PROPELLANTS: STORABLE • CRYOGENIC
PROPULSION SYSTEM: AIRBREATHING (CHEM/NUCL) • ROCKET (CHEM/NUCL) • PP MIX (OVERLAP, SEQUENTIAL)

RECOVERY/REUSE: FULLY • PARTIAL (FIRST STAGE, COMPONENTS, PAYLOAD VEHICLE)

RELATIVELY LOW payload concepts. Boxed areas have been intensively studied.

There are factors other than performance that must be sought out and defined to provide the guidance needed in the technology programs designed to support any decision to move into an uprating or even a new vehicle.

● **Reusable boosters**—Schyner says the reusable vehicle has been studied sufficiently and that the present need is for data. The reusable concepts involve two recoverable stages, air-breathing propulsion and advanced hydrogen-oxygen engines.

The necessary data should come from the hypersonic components work now in progress. The studies indicate another problem—the first stage would be built and in operation long before the second stage, if both entered into development at the same time.

The reusable concepts are going to be a major investment if they reach the development stages. For this reason, frequent use and the prospects of good recovery are essential elements in the cost projections.

To add to the uncertainty in costs, reusable vehicles usually involve some sort of air-breathing propulsion for the descent aspect. This adds a heavy weight penalty for the launch phase, even in ascent.

● **SST results don't apply**—Schyner says the Mach 3 technology of the supersonic transport has been found inapplicable to reusable manned launch vehicles. Every study has verified this, but unmanned uses may be found.

There have been attempts to generate a market by multipurpose configurations involving both NASA and DOD needs together with applications other than manned transport. In addition, the aerodynamic forms studied indicate that lifting re-entry work being carried out today will satisfy a large number of missions if incorporated into the reusable configuration.

The emphasis now involves working with the technical base, mission pictures and the alternatives avalable in 1970-80.

Schyner is trying to find a logical set of growth factors in launch vehicles. It is not known if there is such a thing.

● **Recoverables sensible?**—Another area, really a part of the reusable concept, is the recovery of expendable boosters. Schyner says there is a real need for some hardware work with current boosters to arrive at basic data.

For instance, real cost of refurbishment is unknown. There is no definite configuration. Much more work is necessary in hypersonic deceleration, subsonic parachutes, terminal maneuvers and impact. Schyner, pondering data in hand, is not sure there is any value in the refurbishment approach.

A preliminary feasibility demonstration with full-scale hardware is needed, together with scale-model wind-tunnel and drop tests. The problem to a planner is that this area is complex.

The information on recoverable boosters is a factor in the study of future, reusable systems. The total lack of definitive data on boosters now in operation hampers the studies and limits the intelligent probing of alternate advanced concepts. And it is the advanced vehicle studies that provide direction for planned research and technology. Mission studies alone will not suffice.

● **Advanced H_2O engine seen**—It is now apparent that an advanced hydrogen-oxygen engine will be needed; the technology appears in all future studies. This also means that more data are needed to focus and make more realistic the work done to date—and there is no way to get this unless there is an active program in the advancement of hydrogen-oxygen technology.

Dr. von Braun says the concepts for post-*Saturn* vehicles range from multistage, all-solid to hydrogen-fueled, single-stage-to-orbit, fully reusable vehicles.

One leading contender for major manned planetary exploration in the 1980's is a two-stage, hydrogen-oxygen vehicle using a cluster of M-1-type engines in the first stage and a cluster of high-performance rocket engines—each with a thrust of 300,000 to 500,000 lbs.—installed around a plug nozzle in the second stage.

This vehicle is sized for 1 to 2 million lbs. orbital payload. The first stage would be reusable, but the question of second-stage recovery remains unresolved, say Von Braun.

The Marshall director says the likeliest concept is a launch vehicle and spacecraft with both stages capable of returning to Earth in a lifting-flight mode.

● **Unmanned launch planning**—The major new propulsion under consideration for use in unmanned missions is an engine/stage complex designed, at least, to mate with next lower stage. At the moment, the next lower high-energy stage is the *Centaur*.

Studies are still in progress and V. L. Johnson, director of launch vehicles and propulsion in the Space Science Office says this unit will not be committed to development until there is a fair degree of confidence in freezing the design.

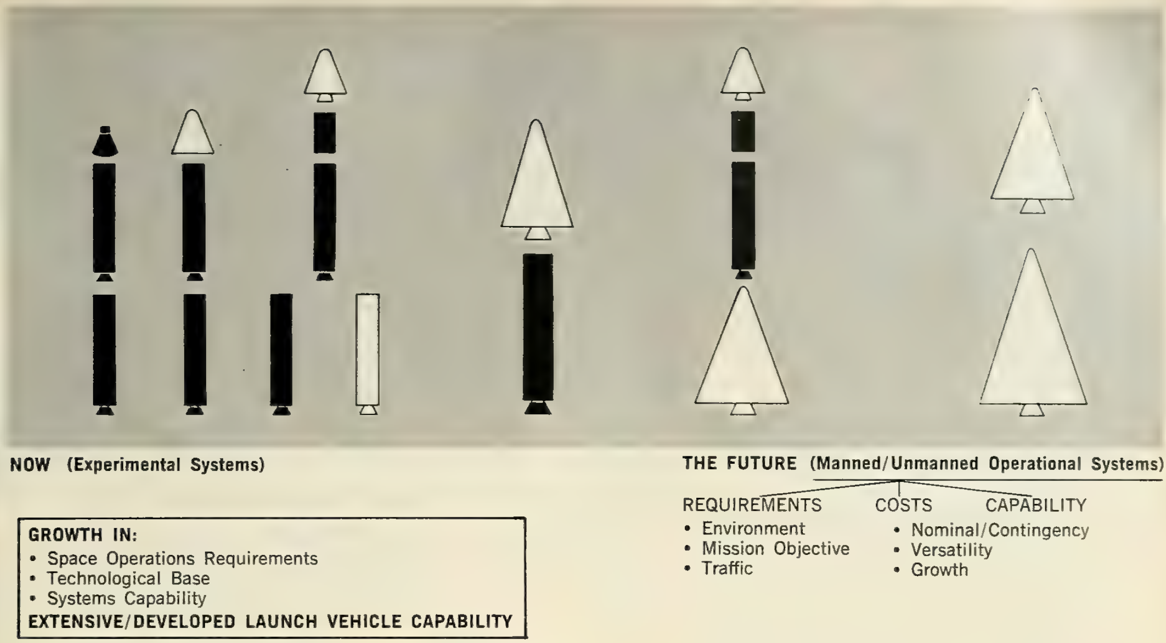
There are no funds for development in the Fiscal Year 1967 budget. The only prediction that can be made is that development will not start before FY '68.

The studies cover a wide range of possibilities with respect to missions. The new engine would be more than just a kick stage—designed merely to add velocity in orbit to change the orbit—although this function could be performed as an auxiliary aim.

Among the possibilities are using the unit in single burn function to add velocity or to design in a multi-burn ability, which broadens the applications tremendously.

Johnson says consideration might even be given to long-term storage in space—on the order of six to eight months. This would permit application of the engine as retro propulsion for a large spacecraft around another planet.

Scientific missions are even more difficult to predict than manned probes.



SHADED vehicles are reusable (flying return ability)—or in case of cylindrical booster, recoverable and refurbishable.

Thus Johnson and his group will continue the studies until all foreseeable changes are accounted for.

The current engine being examined most closely as a contender for this stage is the Pratt & Whitney RL-10 liquid hydrogen-LOX powerplant. Only the general range of RL-10 specifications applies to the study, say spokesmen for the group, since there are improvements and innovations available in the basic design.

The new stage being studied would have a total weight of about 7,000 lbs. —but Johnson says this is not critical. The thrust would be in the 5,000-15,000-lb. range and again, this is not considered critical.

The stage would probably have its own guidance and control and function as part of the launch vehicle. The studies in progress cover all current launch vehicles. Some of the investigations now under way extend into the *Saturn* family of boosters.

There are no other major changes coming in the family of unmanned launch vehicle combinations. The launch of the large *Delta* stage recently marks the introduction of the latest vehicle to the stable.

No missions have yet been identified that would be particularly amenable to the *Titan III-C* launch vehicle, but Johnson says this booster is actively considered in NASA plans. ■

10-MICROPOUND ion thrustor system being developed for ATS.

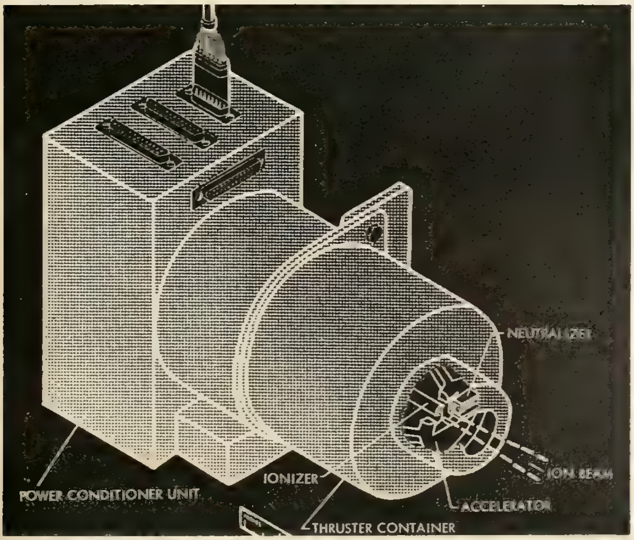
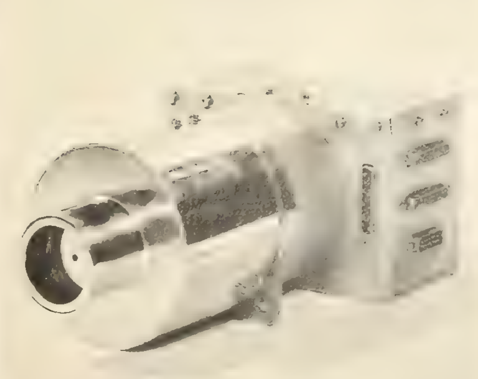


PHOTO OF SAME 6-lb., 15-watt station-keeping system.



Grumman's plans

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Report Will Decide Navigation Role

Joint interagency committee due to deliver recommendations in January; NASA still in comsat field; a status report on ATS

THE EXTENT TO which the space agency will be involved with development of commercially useful navigation satellites should be made more clear within the next several weeks when a long-awaited report by a joint Government agency commission studying this problem is completed.

The commission, which has been in existence for more than a year, includes representatives of five potential user agencies—the departments of Defense, Commerce, Interior and Treasury, the Federal Aviation Agency—and NASA.

Recommendations of this group are expected to be presented to the secretaries of the respective agencies in January, several months later than originally planned. Should the report recommend further investigation of navsats by NASA, the space agency will move ahead with additional studies based on the established criteria, probably using FY '66 funds to support the new work.

Though satellites are likely to get further consideration as a means to improve global navigation, particularly over the ocean, use of this technique is by no means assured and is not without strong competition. Furthermore, earlier concepts of satellites that were to be used principally for navigation have been broadened considerably to include a large communications and data transmission function, traffic control, and search and rescue operations.

Besides the prospect of a completely new satellite, there is the possibility of adapting the Navy's already operational *Transit* satellite for non-defense usage. Two sets of *Transit* equipment are now aboard vessels run by the National Science Foundation and the U.S. Coast and Geodetic Survey for operational trials.

In addition, the Navy's OMEGA long-range VLF ship navigation system, though not yet fully operational, could be expanded to include aircraft navigation, some observers believe, and also challenge initiation of new and more costly satellite designs.

- **NASA not conceding comsats**—NASA is also laying plans for additional work in the space communications field. NASA planners say that the space agency is not out of the comsat business because the Communications Satellite Corporation is now in it. They stress that they will continue to develop technology in this field where they feel it is in the national interest to do so and it is not being done elsewhere.

For example, mission studies are expected to be started shortly on both direct voice broadcast and direct television broadcast satellites.

Both of these studies will be started using FY '66 funds, which have been set aside; however, there is still no task statement for the television satellite. The original intent in the voice broadcast area involved direct satellite to ground-based FM receiver transmission, however this has now been expanded to include short wave AM capability.

Prior to outlining its task statement in the television area, NASA has contracted with Jansky and Bailey, an engineering division within the Atlantic Research Corp., for cost studies of potential trade-offs between satellite power and ground-based receiver sensitivity. On-board power requirements for television satellites, says NASA, could extend even beyond the 35 kwe levels associated with nuclear supplies such as SNAP-8.

- **ATS still king**—Though the studies now in progress or planned for the next several months all will have a bearing upon NASA's future in the applications satellite area, the heart of this entire field is currently tied to the one major approved program—the *Applications Technology Satellite*. It is aboard this satellite that the components and the concepts for future weather, communications, navigation, and data gathering satellites will be put to the test.

The *ATS* program, which will cost about $100 million, currently is programmed for five flights, with three basic missions. However, space agency planners are now evaluating industry response to a NASA RFP calling for an additional satellite to fulfill a proposed fourth mission for *ATS*, that of testing large communications antennas in space.

The current intent is to award at least two 5 to 6-month feasibility studies for this satellite, which would allow initiation of the definition phase early in FY 1967 and also start of development later that year.

ATS-4, as it is now known, probably will be a two-flight program. Launch vehicles under consideration include the *Atlas-Agena*, *Atlas-Centaur*, and *Titan III-C*. The *Saturn*-class vehicles are not being considered.

ATS-4, if approved, will be a synchronous-altitude mission, involving parabolic dish antennas of 30-ft. diameters or larger. The antennas will be capable of operating over large frequency ranges, to frequencies as high as 10 gc, and with greater control and precision pointing than can now be achieved. The program will also explore trade-offs involved in orbital erection for these devices, structural materials, and maneuvering schemes.

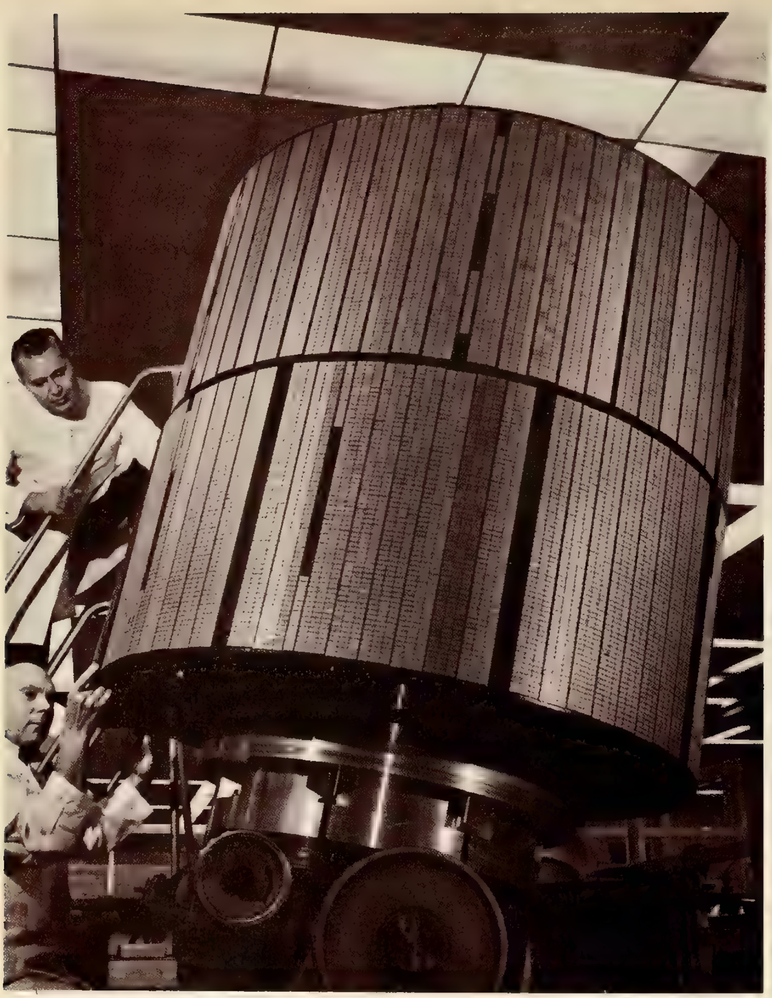
The technology that grows from the use of this satellite is certain to effect virtually every advanced applications satellite since many of these are being planned for stabilized synchronous-altitude operation, and all will depend upon an expanded communications and data function beyond the current state of the art.

For the first three missions associated with *ATS*, five spacecraft will be available, *ATS-A* through *E*. The first one to be launched, however, will be *ATS-B*, now scheduled for late next year. Six months later, *ATS-A* is expected to be flown, with the other three craft following at roughly 6-month intervals. The *ATS-4* missions will probably get underway in 1969.

Experiments for the first two *ATS* flights are the only ones which are now firm.

- **ATS-B experiments** — *ATS-B*, which weighs about 750 lbs., will be the first large satellite to be placed in a geographically stationary orbit; positioned near 151 west longitude above the equator. The satellite will be spin-stabilized. The location was chosen, according to NASA, because it is near the intersection of the geographical and the magnetic equator, which is desirable for several of the on-board experiments. The location also allows visibility from all three *ATS* ground stations—Rosman, N.C., Mojave, Calif., and the Australia station.

Experiments aboard *ATS-B* having major interest for designers of advanced applications satellites include four communications experiments being provided



STRUCTURAL MODEL of synchronous-altitude ATS (Applications Technology Satellite), one of a series being built by Hughes Aircraft Co. under $39-million NASA contract. Five ATS spacecraft are to be launched beginning in late 1966.

by *ATS* prime contractor, the Hughes Aircraft Co., and a new spin scan meteorological TV camera developed by the University of Wisconsin.

ATS-B will carry three types of transponders: one is an FM/FM wideband microwave unit; another is a narrower bandwidth SSB/FM multiple-access unit for more efficient use of the transmitting spectrum; and the third is a VHF transponder for voice communications experiments with aircraft.

The satellite will also carry a Hughes-developed electronically de-spun phased-array antenna. The antenna technique, one of several to be explored during the *ATS* series, will produce a conically shaped beam at 4gc, according to NASA, which will rotate in opposition to the 150-rpm satellite spin rate. The phased-array pattern gain is reportedly 18 db above isotropic for a 1.5% bandwidth.

The VHF transponder is also an FM/FM system. In essence it will substitute a new transponder system for the jury-rigged telemetry transmitter/command receiver combination aboard *Syncom III*, which was used experimentally for non-voice communications with a Boeing 707 jetliner earlier this year.

The Hughes VHF system will be used to provide a duplex voice channel, via satellite, between a ground station and an aircraft beyond the line of sight.

The experiment has attracted considerable interest, and the Federal Aviation Agency and the Air Transport Association, representing the independent air carriers, will take part in this project.

The satellite system includes a 30-watt transmitter and an eight-element phased-array antenna with an 8 to 10-db gain figure. Weight of the antenna is about 15 lbs.

The experiment is also expected to provide data on design of antennas to function in this capacity aboard airliners. Also, range measurements will be made via the VHF system to evaluate VHF navigation possibilities for aircraft.

Other experiments now scheduled to go aboard *ATS-B* include: a nutation sensor developed by the Geophysics Corp. of America; a magnetic field measurement device provided by the University of California; a pair of thermal coating and solar cell degradation experiments provided by the Goddard Space Flight Center; an ionosphere and magnetosphere electron content sensor developed by Stanford University; and several particle measurement devices contributed by Rice University, TRW, Inc., the University of Minnesota, and the Bell Telephone Laboratories.

An ion-engine thruster, intended for use as an experimental station-keeping device aboard *ATS-B*, has slipped to the third *ATS* flight instead. The 6-lb. thruster, which produces 10-micropounds of thrust, has been developed by NASA's Lewis Research Center.

- **ATS-A experiments**—The *ATS-A* satellite, planned for mid-1967, will involve placing 780 lbs. in a 6,000-mile circular orbit inclined about 28 degrees to the equator. The spacecraft will carry the General Electric Co.'s three-axis gravity gradient stabilization system into orbit for the first time in a test certain to have major implications for future operational systems. The same equipment is expected to be used on *ATS-D* and *E*, but at the higher, synchronous altitudes. The GE system involves four 133-ft.-long booms which extend from the satellite to provide the basic stabilizing torques needed to achieve Earth orientation.

Microwave communications experiments to be carried are the same as with *ATS-B*, except that there is no VHF experiment and horn antennas are used to replace the de-spun array in the gravity stabilized satellite. Antenna gain is expected to be also about 10.5 db. Of interest to communicators, NASA points out, will be the performance of the multiple access equipment aboard a moving satellite, with its associated Doppler shift, in comparison to one in a stationary orbit.

The meteorological TV aboard *ATS-A* will be *Nimbus*-type vidicons built by RCA. NASA scientists are anxious to test these cameras at higher altitudes and also in the presence of the gravity gradient stabilization system. There is some question regarding the degree to which moving parts in the camera recording system will interact with the stabilization.

Among the other experiments going aboard *ATS-A* are: four from Goddard —the two degradation experiments of *ATS-B* plus cosmic radio noise and

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electric field experiments; a VLF power spectrum analysis experiment from Bell Telephone Laboratories; and three particle measurement experiments.

- **After ATS-B and A**—Beyond *ATS-B* and *A*, some basic mission profiles have been planned. Experiments have not yet been selected, though proposals have been solicited, and more than 200 have already been received.

ATS-C will resemble the *B*, in that it is spin-stabilized and will be placed into a synchronous-altitude orbit. However, the satellite will probably be placed over the Atlantic.

Replacing the electronically de-spun antenna of *ATS-B* will be a new mechanically de-spun device under development by Sylvania Electric Products, which NASA engineers say will have a higher gain figure. The unit reportedly will weigh about 9 lbs.

Also planned for *ATS-C* is an experiment utilizing the ground-based OMEGA position fixing equipment. Intent is to put a VHF OMEGA receiver aboard an aircraft. A transponder would then broadcast these signals to the *ATS-C* which would in turn relay them to a ground station for position computation. This would allow reduction of the positional computation equipment aboard the aircraft. This concept, says NASA, could also be used in conjunction with a VHF communications transponder to develop techniques for air traffic control.

In the meteorological TV area, another equipment candidate for *ATS-C* is a new image dissector camera system under development by ITT.

Also proposed, but not yet approved, is a millimeter wave propagation experiment aimed at investigating ionospheric effects from a spacecraft at frequencies above 8 gc.

ATS-D and *E* are both to resemble *ATS-A*, in that they will both be gravity-gradient-stabilized craft; however both of these satellites will be used at synchronous altitudes rather than at the 6,000-mile level at which *ATS-A* will be flown. Both the *D* and *E* satellites will probably make use of either ion engine thrusters or a new solid subliming rocket for experiments in the attitude control area. A separate gas jet system will also be on-board.

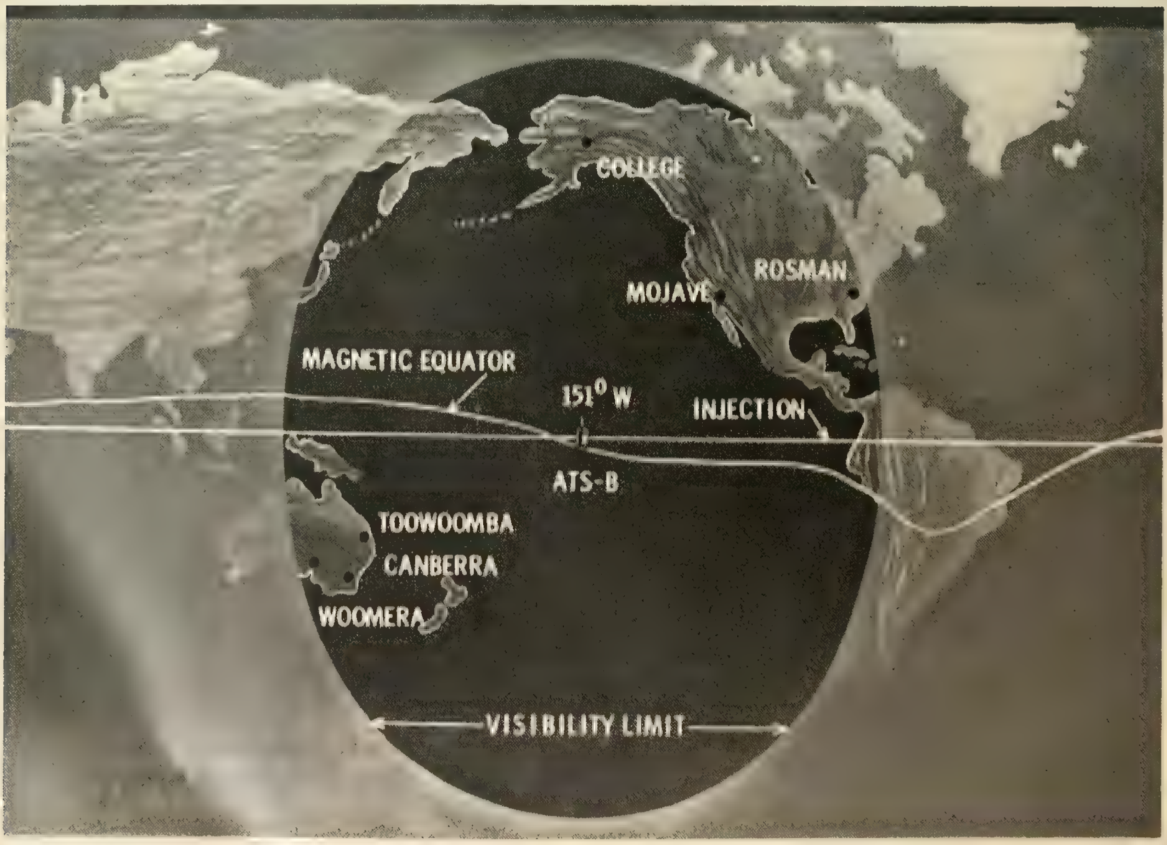
In the area of long-range data collection using satellites, NASA's first extensive effort will come in mid-1967 when the IRLS (Interrogation Recording Location System) is launched aboard the *Nimbus-B* satellite into low Earth orbit (M/R, March 8, p. 35 and Sept. 6, p. 42).

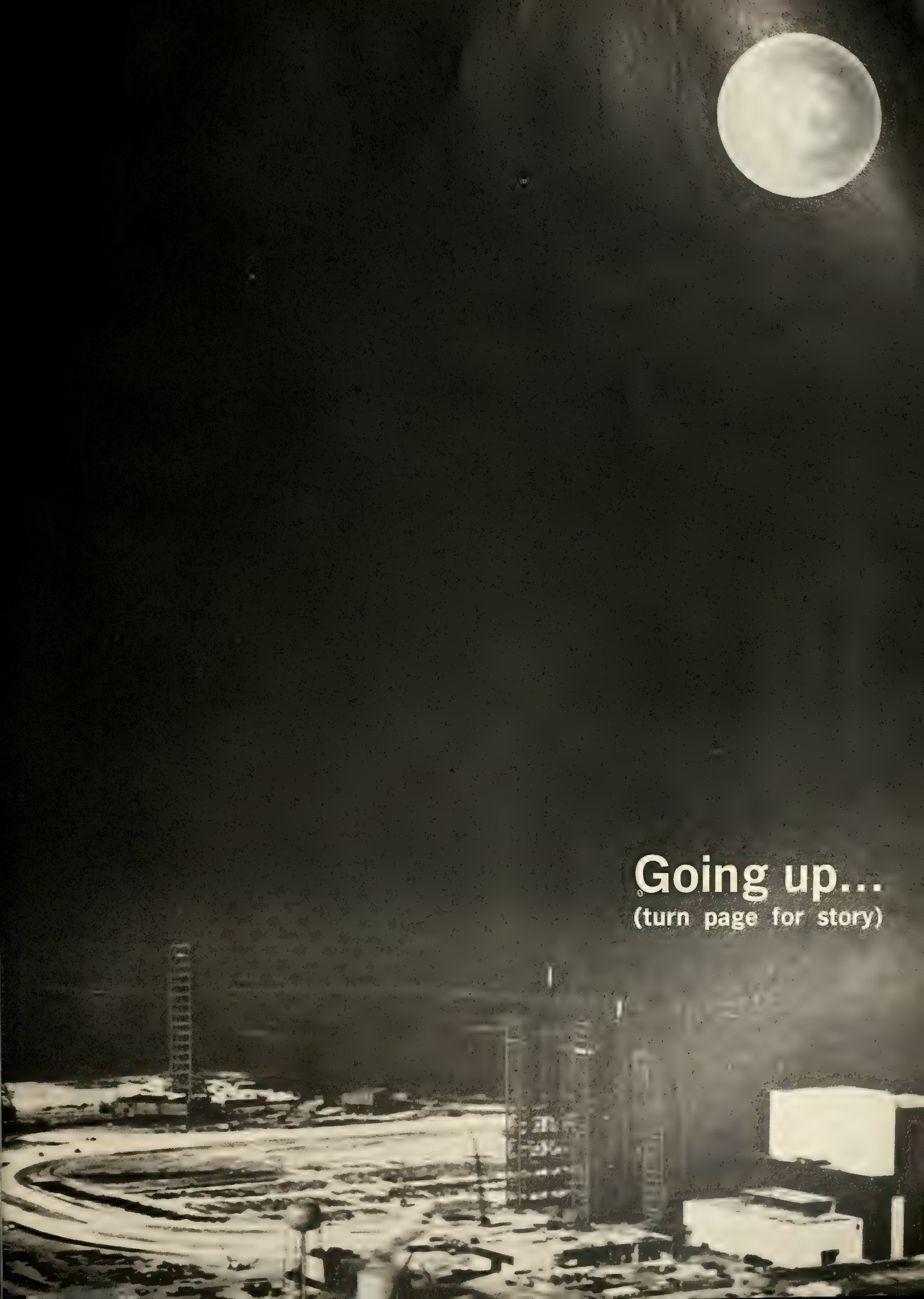
The intent of the project is to monitor a variety of different fixed or mobile weather data collection sensors with the satellite equipment. NASA will sponsor only a few of those stations expected to be involved in the experiment, probably one fixed station, an aircraft station, and perhaps a mobile, truck-mounted unit.

The Navy's OMEGA system also fits into this area. Using the IRLS approach, the job of fixing the position of the sensor once it is located rests with the satellite equipment. Using OMEGA equipments aboard the stations to be monitored would fix the platform's position and transmit this along with the accumulated weather data to the satellite and therefore minimize the satellite computation problem.

Although some technical problems lie ahead, there is optimism within NASA and other agencies over widespread use of satellite-monitored air and surface stations. ■

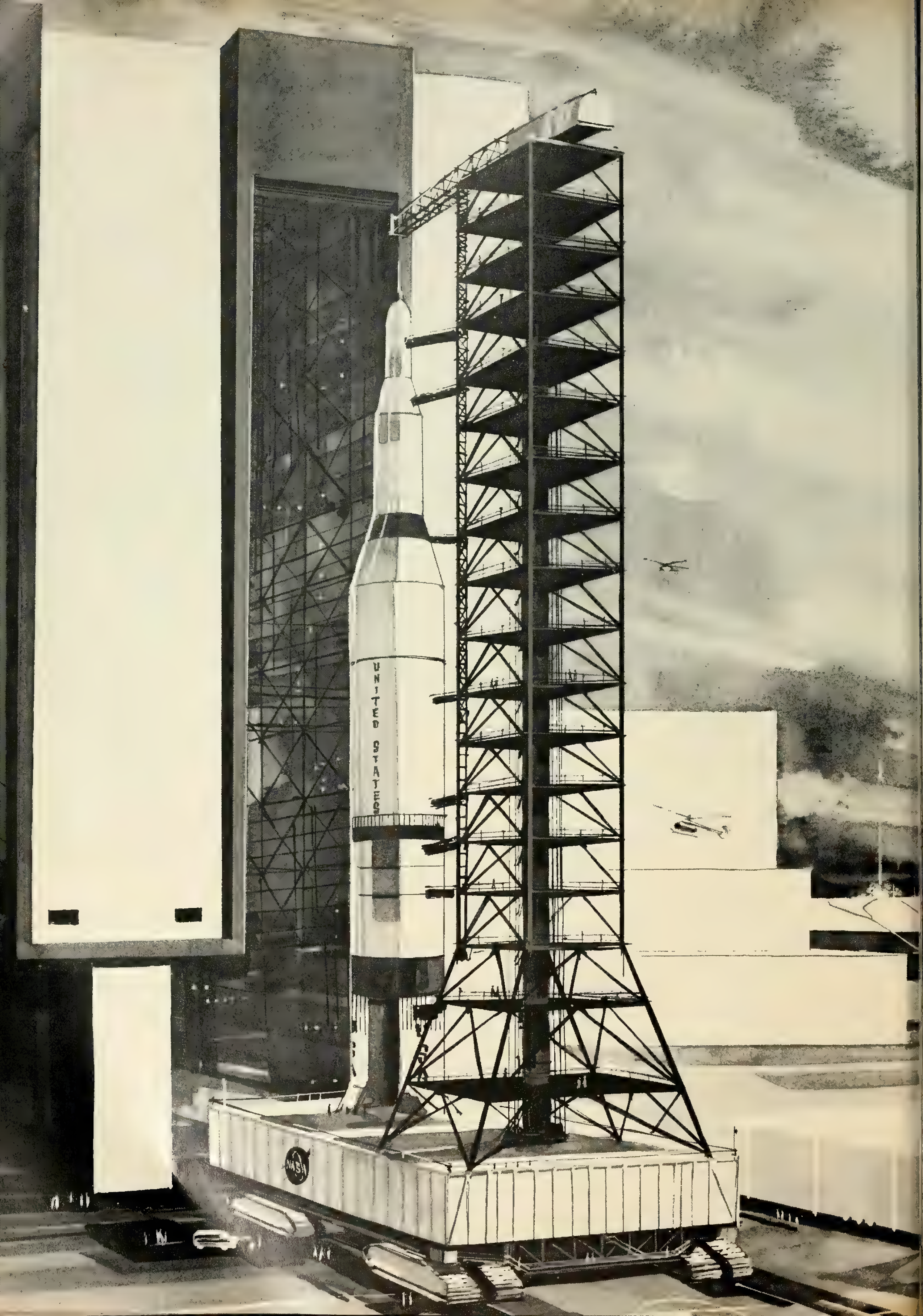
ATS-B (Applications Technology Satellite B), scheduled for launch in 1966, will be put into synchronous orbit 22,300 mi. above Earth at 151 deg. west longitude. From this position, it will communicate with ground stations at Rosman, N.C., Mojave, Calif., and Toowoomba, Australia.





Going up...

(turn page for story)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For the manned moon shot: the free world's largest launch complex.

The size of new facilities, now nearing completion at the National Aeronautics and Space Administration's Launch Complex 39, Merritt Island, Florida, surpasses any structures or machines previously used for rocket launches in the United States. The Apollo 3-man space craft and the Saturn V Rocket will be assembled in the world's largest structure with a volume of 129 million cubic feet—one and one-half times as large as the Pentagon. Here an immense Mobile Launcher mounted on a steel platform half as big as a football field will hold the 362-foot-high Saturn V in place. When the assembly is completed, a Crawler Transporter will carry the tower and the Saturn V to the launch pad three miles away.

The Vehicle Assembly Building is so large that the 45-story New York Hilton hotel would fit into one doorway. For the structural framework, designers used A36 Steel, a basic grade to meet strength requirements. It is economical, and goes up fast enough to keep pace with tight erection deadlines. Coupled with sound design, the A36 framework can support heavy loads and provide stability under hurricane winds up to 125 mph at the thirty-foot level and 195 mph at the roof level—526 feet high.

In April, 1965, American Bridge Division of U. S. Steel bolted the last structural member in place. This structure required 57,000 tons of steel, fabricated in plants throughout the country and shipped to Tampa, Florida, where it was unloaded, sandblasted, painted and hauled by truck to the site at Merritt Island. This demonstrates a real production, scheduling and erection capability.

Mobile Launcher. This is a gigantic tower 380 feet high fabricated from A36 Steel and mounted on a half-acre, two-story steel base. The entire Saturn V Rocket, including the payload, will be launched from this platform. Eight steel umbilical arms, varying from 35 to 45 feet in length, will swing out like cantilever bridges and will provide access for personnel, and support for electric power and communication lines, air lines and propellant lines. The arms will be made of field-weldable USS "T-1" type A Steel tubing. "T-1" Steel's high yield strength of 100,000 psi (permitting a reduction of thickness) helps to keep tower weight to a minimum. Of equal importance, "T-1" type A Steel also will maintain the required strength even under the high temperature created by the rocket motor blasts as the space vehicle "lifts off" for the moon.

Crawler Transporter. This mammoth unit will move under the tower's platform base and pick up the mobile launcher and Saturn V Apollo vehicle and move them to the launch pad 3 miles away. Each transporter is bigger than a baseball infield and is 20 feet high with leveling jacks retracted. It will carry a load of over 6,500 tons on eight crawler tracks. USS Cor-Ten High Strength Steel is used where it counts—in the chassis—because its strength up to 4" thick enabled a lighter design to be used for the forces involved.

USS capability in related Apollo/Saturn V projects.

Mississippi Test Facility. To meet NASA's requirements for the storage of liquid oxygen, liquid nitrogen and liquid hydrogen, U. S. Steel supplied USS 18-8S type 304 stainless steel plates. These liquids do not attack this stainless grade. No harmful compounds form to clog valves and pipes. Along with this cleanliness, stainless steel has excellent toughness at temperatures as low as −452°F.

Saturn V Test Stand. For the dual test stand where the static firing of the first stage of the Saturn V will take place, U. S. Steel supplied steel H piles capable of supporting dead and live assembly loads in addition to withstanding operating loads when the rocket engines generate 7.5 million pounds of thrust.

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U. S. Steel not only had the capacity to produce, fabricate, and erect much of the steel used in Launch Complex 39 and related projects, but also has a group of technical personnel that is experienced in application problems. These capabilities are a major reason why construction advanced on schedule. For more information on our complete family of steels for construction, write United States Steel, Room 8621, 525 William Penn Place, Pittsburgh, Pa. 15230. *USS, "T-1," Cor-Ten and Tri-Ten are registered trademarks.*

United States Steel: where the big idea is innovation

Front cover photo: A36 Steel framework of the Vehicle Assembly Building of Launch Complex 39 where moon rockets will be put together. Size when completed: high bay—518 x 442 ft. x 526 ft. high; low bay—442 x 275 x 211 ft. high. Doors 456 ft. high.

Opposite Page. Crawler-Transporter removing platform, launcher and Saturn V Rocket from Vehicle Assembly Building.

Prints of this artwork, suitable for framing (16" x 20"), are available in limited quantity. For your free copy—write us at the above address.

Design and construction supervision: Canaveral District, U. S. Army Corps of Engineers.

Design team, URSAM, was organized specifically to design the VAB and support facilities. It is a joint venture of engineers consisting of the offices of Max O. Urbahn, planning and architectural; Roberts and Schaefer Co., structural; Seelye Stevenson Value & Knect, mechanical, electrical, civil; and Moran, Proctor, Meuser & Rutledge, foundation engineering. William D. Alexander is URSAM Project Manager. Anton Tedesko, in charge of structural engineering for the VAB, is Vice President of Roberts and Schaefer Co. Prime Contractor: Morrison-Knudsen Company, Inc., Perini Corporation and Paul Hardeman, Inc., a joint venture. Fabricator & Erector of VAB framework: American Bridge Division, U. S. Steel.

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Future Hinges on Manned Project Plans

New vehicle developments including Explorers, Observatories and probes await decisions on experiments for piloted craft

THREE ADDITIONAL *Radio Astronomy Explorers,* an extension of the *Orbiting Geophysical* and *Solar Observatories,* a possible *Solar Radio Observatory,* and a solar radio probe are being considered by NASA for the 1970's.

The space administration's scientific satellite effort is in a period of transition. The future growth and direction of new vehicles will depend in large part on decisions to be made concerning experiments in several of the manned projects and the *Apollo* Applications program, according to Dr. John W. Townsend, Jr., deputy director at Goddard Space Flight Center.

The observatories are now well along in development. While early launches of the *Orbiting Geophysical Observatories* and the *Orbiting Solar Observatories* have been somewhat disappointing, much has been learned which will improve the design of the remaining craft in the two series.

In the *OGO* series, seven flight vehicles have been approved. Two have been launched, both with only partial success. One is still operating. Yet NASA officials have indicated a probable follow-on to the program extending it through the 1970's with a new generation of vehicles.

Paralleling these series are the *OSO*'s —with eight flights approved, three already launched—and the *Advanced OSO* program, two years along in development.

Four *Orbiting Astronomical Observatory* flights are planned. Despite problems in development of some of the planned experiments, NASA is already looking ahead to additional vehicles extending the program to at least 10 years. Future launch rate, following the first four, could be one per year.

With a three-year lead time required to add new vehicles to the observatory programs, follow-on contracts will have to be awarded in the 1967-1968 period to assure flight continuity, said Jesse L. Mitchell, deputy director of physics and astronomy in the Office of Space Science & Applications at NASA Headquarters.

The *Explorer* satellites represent a nearly endless program. With almost 30 already launched (most successfully), over 20 more are scheduled for launch during the next three years. They fill the more specialized needs in expanding scientific knowledge. They include not only the small highly specialized ionospheric sounders and distant monitoring probes, but also the new geodetic survey vehicles, *GEOS* and *PAGEOS* (polar-orbiting) and the ambitious *Radio Astronomy Explorer (RAE).*

- **General trends**—While there have been threats of budget cuts in the scientific satellite program, it has come through year after year relatively unscathed. The reasons are readily apparent. The gaps in space-scientific knowledge are broad and the need for fundamental knowledge is so entwined with the safety and success of future manned missions that it is nearly impossible to determine which study areas are of marginal importance to the overall effort.

As indicated earlier, the scope and timing of *Apollo* applications will have an effect. In that program, man will have a service function in the performance of space experiments. Thus, experiments that might previously have been delegated to the *Explorer* satellities could be grouped into the manned project.

On the other hand, there will always be a need for experiments in hazardous areas, in long-duration simple-measurement projects, and in the long-duration long-distance probes.

Dr. Townsend said a new breed of scientific craft affording lower costs and simpler integration of experiments is required, together with a program offering easier access for experimenters. There is demand for specialized electronics for experiments and a growing need for use of adaptive telemetry, data compression and on-board processing.

There also appears, however, to be a continuous requirement for the observatory-type vehicle. A vehicle series that can carry a large number of compatible but different experiments over a long time period meets interdisciplinary demands. Further, there may well be an advantage in a synergistic approach.

In some programs, there may well be a long time overlap of the manned and unmanned approaches to data collection—particularly in the field of space optics. The *OAO* series will provide much new data not obtainable through the Earth's atmospheric envelope. But the perturbations due to man's presence on larger orbiting optical platforms may prove to be intolerable.

The answer may well be a normally unmanned platform that is boarded at regular intervals for service and realignment. Or the Moon may prove to be, for many studies, a better optical platform. Whatever the final approach, it is certain that the desire to employ film storage and the need for film change and recovery will bring man into the loop.

By the late '70's a manned orbiting telescope probably will be required, according to Mitchell, and could employ optics to 120-in.-dia. Stellar instruments 50-60 ft. long may also be needed, he said. Technically, instruments of such size are feasible, but the means for deployment or assembly in space would have to be developed. Mitchell said the goal embodied in such advanced concepts would be the establishment of a National Space Observatory.

- **Possible projects**—There is increased interest in using scientific satellites for solar studies. The *Explorers,* for example, may be used to extend X-ray astronomy. NASA is now looking at proposals for such experiments.

A Solar Radio Observatory series offers interesting possibilities, particularly for studying the period of maximum solar activity. Mitchell suggested these might be small vehicles (*Scout*-launch size) that would perform measurements in the 0.25-16 mc range.

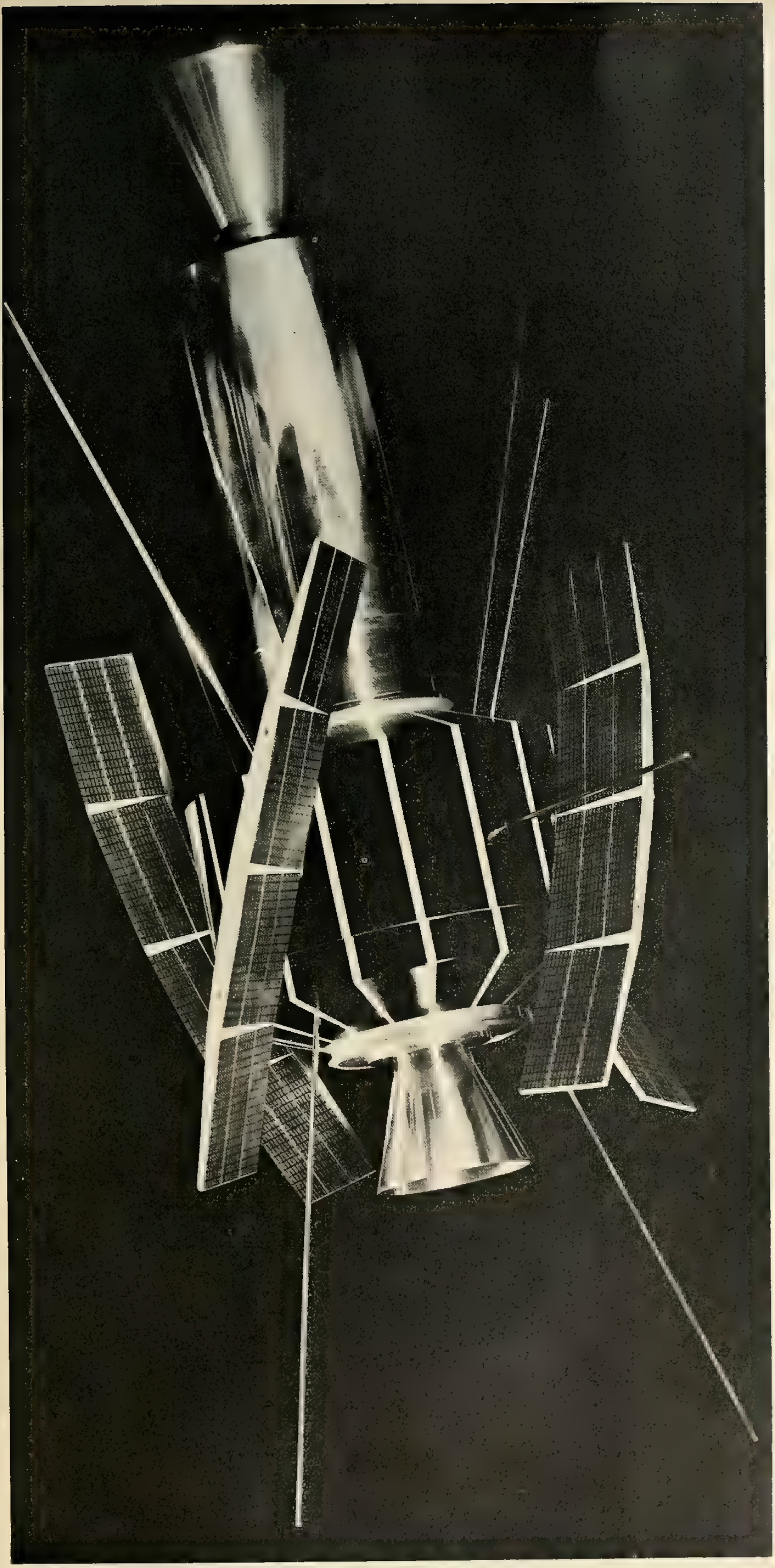
Other projects being considered:

—Atmospheric drag measurements in the 130-140 km altitude range to determine air density. A satellite within a satellite might be used to obtain a drag-free volume.

—A gyro-precision experiment to check Einstein's General Theory of Relativity.

—A small standard satellite for obtaining particle measurements during the solar maximum.

- **Sun Blazer**—There is a growing trend toward directing solar investigating vehicles (such as the *Pioneer* series) closer and closer to the Sun, particularly during the solar maximum. Present plans call for craft to approach within 0.8-1.2 astronomical units (au), but 0.5 au would be better.



MOCKUP of Radio Astronomy Explorer shows basic design and arrangement of 1,500-ft.-long V antennas that will collect radio emissions from space below 15 mc.

In addition, a sounding rocket analog to deep space is being considered with the *Sun Blazer* study.

Massachusetts Institute of Technology, working with NASA's Langley Research Center in an outgrowth of the *Trailblazer* project, has derived a concept for building a 1,000-watt peak-pulse transmitter capable of operating in close proximity to the Sun. The 15-lb. satellite, transmitting 1-millisec pulses, would be used to measure electron density in the near-Sun "atmosphere."

Launch vehicle being considered for *Sun Blazer* is a five-stage *Scout*.

- **Galactic probe**—For interplanetary studies out to 5 au (and beyond 25 au in the future), a Galactic Probe is being studied. It would be employed to check the solar wind effect on Earth-received cosmic radiation. This would be achieved in part by measuring cosmic rays out to Jupiter, for example, and determining the boundary between the Earth-Sun, or solar, space and extra-solar space. Such an experiment might be considered, NASA said, for the mid '70's.

A nuclear power supply probably would be needed to solve the expected communications problem.

- **RAE program**—At the present time Goddard Space Flight Center has two approved flights for the *Radio Astronomy Explorers*, but three more are planned.

Principal mission for the *RAE* is to look at wavelengths at and below 1-mc from beyond ionospheric cutoff. Each craft will be designed for a minimum 1-year operating time in space.

Because of the low frequencies to be measured, unusually long antennas are required—1,500-ft.-long for *RAE-A* and *-B*. All five vehicles could be essentially the same and be employed throughout a half solar cycle. However, higher-gain, lower-frequency antenna variations may be employed. (It is even possible, said Mitchell, that AA might be employed to verify operation of very long antenna extensions in space.)

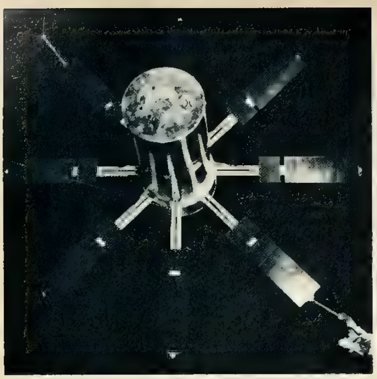
Basic design for the *RAE* satellite is now frozen. Weighing 380 lbs., plus a 175-lb. apogee kick motor, the vehicle will measure 36-in.-dia. by 31-in.-high.

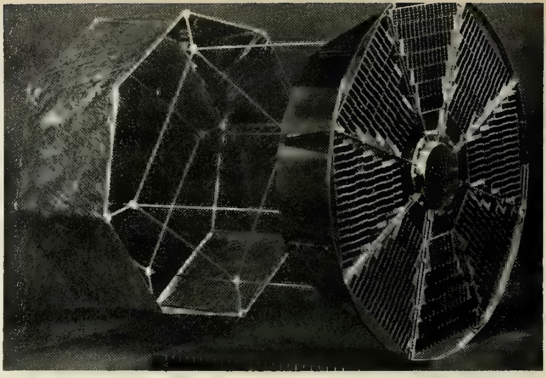
It will be launched into a 6,000 km-altitude elliptical transfer orbit atop a *Delta* DSV-3J rocket from the Western Test Range. The kick motor will be used to effect a circular orbit.

A 60° angle of inclination retrograde launch, said NASA, will assure at least 7-month operation in space outside the Earth's shadow.

Five prime objectives will be sought in the project:

—Observe low-frequency (lf) Earth radio storms believed generated by solar particles interacting with the Earth's radiation belts.





LEFT: AOSO, Advanced Orbiting Solar Observatory being developed by Fairchild-Hiller Corp., is 1,450-lb. spacecraft which will first fly in 1969. RIGHT: Sun Blazer, for all practical purposes a deep-space sounding rocket probe, will be fired into close proximity with the Sun while transmitting to Earth.

—Gather data on lf solar radio bursts to aid in study of solar-corona electron temperature and density out to 20-30 solar radii.

—Monitor large discrete radio noise sources.

—Obtain an electromagnetic map of the galaxy at frequencies from 0.3-15 mc.

—Study Jupiter emissions of lf sporadic noise bursts.

The first *RAE* launch is planned for the first half of 1967, to make certain an operating vehicle is in orbit prior to the June, 1968, solar maximum, according to John Shea, *RAE* Project Manager. *RAE-A* and *-B* will overlap.

The antennas are made up of two 1,500-ft.-long V's. Together they form an X with angles of 60° top and bottom (see photo). A small 100-ft. dipole crosses the intersection of the V's.

Through a switching arrangement, the upper and lower position of the X antenna can be used separately or the entire X dipole can be used. The craft will be Earth-oriented, and gravity-captured, and the longitudinal axis of the vehicle will be aligned with the local vertical.

Shea believes that careful design of the electronics subsystems will ensure minimum RF interference between components. Very-low-noise instruments will be used and the converters—normally the source of greatest noise—are being specially built to avoid interference.

Step-by-step frequency scanning will be employed over the 0.3-15 mc range. NASA will be able to compare any stored signals at 15 mc with the same frequency received directly from space at NASA ground stations.

A tape recorder in the craft will store data collected during each revolution and provide readout to ground of all the data in 10 min. (a total period of 224 min. is planned).

A real-time readout at low power also will be possible.

Transmitter power will be at ¼ w and 2½ w. A PCM telemetry system using 22-in. antennas for each transmitter will be provided. The power supply will be from solar cells and nickel-cadmium batteries.

Four Ryle-Vonberg radiometers will be employed—three in use, plus one standby.

Two vidicon monitors will be used to check antenna extremity position of the upper V. Each camera has a 60° cone (pyramidal) field of view. Considerable perturbations are expected to be experienced by the long antenna legs due to solar pressure, temperature (back-to-front surface differential of 2° F) and orbital effects. Variations in antenna position of from 40-90 ft. are anticipated. Thus the 60° V angle will actually be squeezed to a 50° effective angle.

Vidicon readout will require 120 sec. (13 sec. per frame).

In operation, the *RAE* systems will spend 9½ min. data gathering and ½ min. in recalibration continually.

- **Anchored IMP** — Another new satellite planned by NASA's Goddard SFC is the Anchored *Interplanetary Monitor Probe.*

Two vehicles are approved which will be used in lunar orbit to investigate, in the vicinity of the Moon, characteristics of the interplanetary magnetic field, solar-plasma flux, interplanetary dust distributions, solar and galactic cosmic rays. Also, it will be used to study the magnetohydrodynamic wake of the Earth in the interplanetary medium at lunar distances every 29½ days.

Other secondary missions include data on the lunar gravitational field and on any possible lunar ionosphere. ■

LEFT: OGO-C, the Orbiting Geophysical Observatory, is shown atop thrust-augmented Thor-Agena D prior to polar launch Oct. 14 from Western Test Range. It is now transmitting data one day out of three after suffering malfunction in flight shortly after achieving orbit.

APPROVED FUTURE SCIENTIFIC SATELLITES FOR PHYSICS AND ASTRONOMY MISSIONS

PROJECT	NUMBER OF MISSIONS	TIME PERIOD
OSO	5	1966-1969
AOSO	4	1969-1972
OAO	4	1966-1968
OGO	5	1966-1969
EXPLORERS:		
Atmosphere Explorer (AE-B)	1	1966
ISIS (Canada-U.S.)	4	1965-1969
United Kingdom	1 plus backup	1967
IMP	2	1966-1967
Anchored IMP	2	1966-1967
Air Density/Injun	1	1967
San Marco (Italy)	1 plus backup	1966-1967
French FR-1A	1 plus backup	1965
Solar Explorer	1	1965
GEOS	1	1967
PAGEOS	2	1966-1967
Radio Astronomy Explorer (RAE)	2	1967
Owl (Rice Univ.)	2 plus backup	1967
ESRO	2 plus backup	1967

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Effort Embraces Entire Solar System

Studies authorized for probes of Venus, Jupiter based on 1972 opportunities; first flight to comet is 1974 possibility

THE SUN, VENUS, Jupiter, comets and asteroids, are NASA's early benchmarks in a program expected to begin in the 1970's to explore the entire solar system with unmanned spacecraft.

Anticipating extensive solar work, the first of the present *Pioneer* series of four probes is scheduled for its flight before the end of this year as a preliminary step in a program to reach within 0.1 astronomical units (au) of the Sun, possibly by the late 1970's or early 1980's. *Pioneer* research and development will cost about $45 million.

Work on the second series of *Pioneer* probes, unofficially known as *Extended Pioneer,* is expected to start in Fiscal '67, if granted approval, and proceed for about three years. Object will be to reach within half an au of the Sun, M. J. Aucremanne, NASA's Acting Director of Interplanetary and Solar Probes, told MISSILES AND ROCKETS.

He foresees a succeeding *Pioneer* series striving to reach within 0.3 au of the Sun, sometime between 1972 and 1978. And the final series reaching within 0.1 au of the Sun. Pioneer probe work is performed at Ames Research Center.

- **Planetary probes** — Although NASA has not approved plans for advanced unmanned missions to Jupiter or Venus, space agency studies of both missions are based on 1972 opportunities. Missions to comets and asteroids are undated, although a probe to comet Encke in 1974 is possible.

The goal behind the interplanetary studies is to begin in the 1970's to explore all the planets and asteroids, "realistically after 1975," said William T. O'Bryant, advanced projects manager in NASA's Lunar & Planetary Programs Office. "We are presently authorized to study probes for Venus, Jupiter, the comets and asteroids."

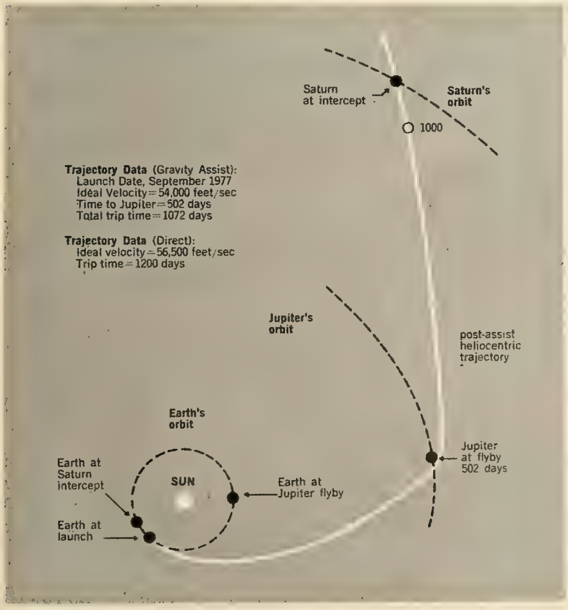
He noted that Phase A studies are now going on with respect to Venus and Jupiter, and pre-Phase A studies with respect to outer planets, comets, asteroids and other solar system bodies such as the moons of planets other than Earth. He included studies that might involve trajectories out of the plane of the ecliptic and gave as an example, "a flight to Jupiter, where we may not want to go through the asteroid belt."

Phase A work involves feasibility studies, conceptual designs and mission analyses. The next step, Phase B, is project definition. On the other hand, O'Bryant explained, pre-Phase A work includes a continuing survey of the means of exploring the planets, and is updated with new techniques as they arise, such as gravity-assist for cutting down on the ideal velocities needed to achieve specified missions.

- **Venus**—"We have a number of concepts for exploring Venus," said O'Bryant, "and we are now taking the first step in sorting them out." He was speaking of variations on the fly-by mode only. This involves a fly-by bus, which will drop probes into the Venusian atmosphere. Initially, contracts will be let for feasibility and design studies of the bus and its probes, and their integration into one mission. "The atmospheric entry probes will want to measure primarily surface temperature, and pressures for a pressure versus altitude profile," he said.

O'Bryant emphasized there is "no approved plan for the Venus mission," but for study purposes his office is designing around the 1972 opportunity to the planet.

The conceptual design of the fly-by


Saturn
at intercept
Saturn's
orbit
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Trajectory Data (Gravity Assist):
Launch Date, September 1977
Ideal Velocity = 54,000 feet/sec
Time to Jupiter = 502 days
Total trip time = 1072 days
Trajectory Data (Direct):
Ideal velocity = 56,500 feet/sec
Trip time = 1200 days
Jupiter's
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Earth's
orbit
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at flyby
502 days
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Saturn
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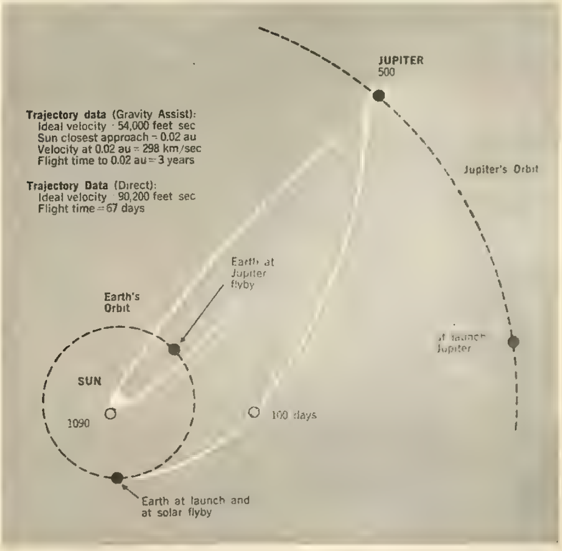
LEFT: Plan for Saturn probe by way of Jupiter.
BELOW: Plan for solar probe by way of Jupiter.


JUPITER
500
Trajectory data (Gravity Assist):
Ideal velocity · 54,000 feet sec
Sun closest approach = 0.02 au
Velocity at 0.02 au = 298 km/sec
Flight time to 0.02 au = 3 years
Trajectory Data (Direct):
Ideal velocity · 90,200 feet sec
Flight time = 67 days
Jupiter's Orbit
Earth at
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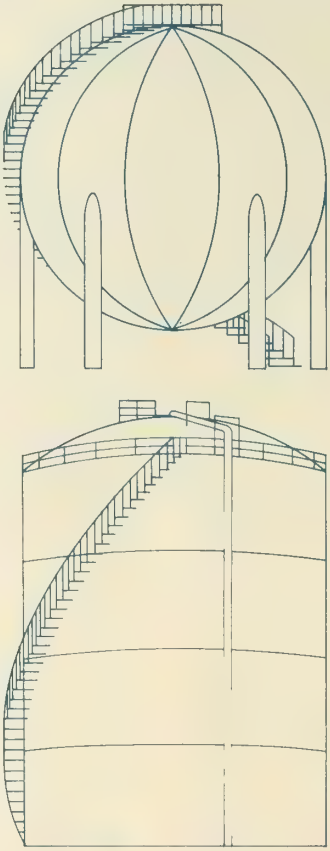

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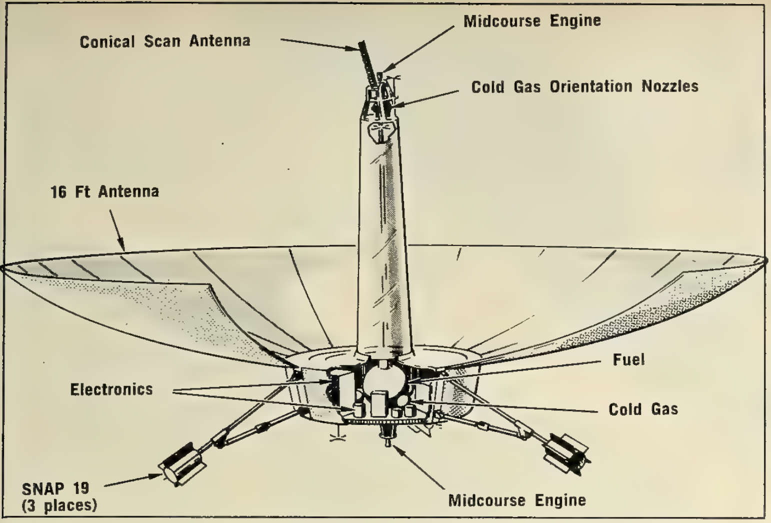

PROPOSED precursor for deep-space planetary fly-by (TRW Systems Group).

bus will begin this Fiscal Year, and contracts for the study of the entry probes are expected to be let within two months.

The present primary aim of the Venus study is to define requirements and see if *Voyager* can meet them, or what modifications, if any, would be needed in the spacecraft to accomplish the mission.

The present plan calls for Langley Research Center to monitor the Venus probe work. Two different concepts will be investigated: high-speed entry into the Venusian atmosphere and balloon entry. The balloon or "floating" probe will keep sensors functioning longer because they will not be so quickly subjugated to the planet's high surface temperatures.

Jet Propulsion Laboratory will take the Langley work, combine it with studies of its own, and put the package out on contract for a study of the entire fly-by mission leading to a conceptual design.

- **Jupiter**—The route to Jupiter involves a different concept than to Venus, namely, the use of a precursor for the initial contact with the planet. *Mariner IV,* for example, was the Mars precursor and *Voyager* will do the detailed investigation of the planet.

O'Bryant sees the Jupiter precursor as small, lightweight and relatively inexpensive. It will contain "only a few of the most important experiments aboard," he said. "We want to find out what the surprises are early so we can do a better job designing the follow-on spacecraft for the detailed investigation of the planet." To this end, several studies are authorized.

General Dynamics, Fort Worth, Tex., is starting work under NASA contract to set up requirements for spacecraft that could do a detailed investigation of Jupiter. *Voyager* will be considered as a likely candidate, and the study may possibly show how *Voyager* could be modified for it—or why it could not be. At the same time, the study may provide inputs to the *Voyager* program that could effect changes whereby the spacecraft could serve Jupiter as well.

A contract is about to be signed that will study a spin-stabilized precursor. This is the first of two concepts to be examined; the second, a three-axis stabilized platform like *Mariner*.

Simultaneously, JPL will make a fundamental parametric study of spacecraft for all the outer planets: Saturn, Uranus, Neptune, Pluto. The study will also consider the technical problems the asteroid belt will bring up. Out of these parametric studies NASA will choose the best concept for Jupiter; and next year contract for a specific Jupiter mission analysis and conceptual spacecraft design.

O'Bryant reaffirmed there are no approved plans for a Jupiter flight. Favorable flight opportunities occur every 13 months. For present purposes, NASA will probably study the 1972 opportunity.

- **Spinning precursor**—If Jupiter experiments are restricted to fields and particles, the question to be answered is whether the mission can be carried out with a spinning spacecraft. At present the answer is considered to be, "yes, maybe you could," said Peter N. Haurlan, JPL Manager for Future Projects. A typical small spinning probe would operate with about 20 watts of RF power and use a 2 to 4-ft. antenna dish. Information rates of 2-3 bits per second

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and 1 bit per minute are believed to be acceptable for field and particle measurements. Because of this there is even a small chance that an omni-directional antenna could be used to avoid the pointing requirements altogether.

Once the Jupiter mission is funded it is very likely that probes for the outer planets would develop out of this program.

Jupiter itself provides a very large gravity assist and makes possible a "grand tour" of the solar system in the years 1978, 79, and 80, because of favorable geometry of the outer planets. This opportunity, which occurs every 180 years, enables a probe to fly past Jupiter to Saturn and swing out to Neptune. Total flight time to Neptune is a mere seven years, instead of the 35 years required without the dual gravity assist. If information can be got back from Jupiter at about one bit per second, then it will be possible to return data from Neptune at somewhat better than one bit per minute.

Solar power is not likely to be used for missions to Jupiter unless a solar-electric propulsion spacecraft is selected for the mission. Beyond Jupiter radioisotope thermal generators would be required for electrical power if a start is made on a probe design within the next two years. If the start were delayed 5-10 years, fuel cells might possibly provide the power source.

- **Less urgent studies**—Studies with much lower emphasis than those concerning Venus and Jupiter are mission-to-comet studies and lunar-orbiter studies.

The mission-to-comet study is in-house at JPL and will not go out of house for FY '66. "The next good mission possibility to a comet is in 1970, but we probably won't send anything up then," said NASA's O'Bryant. He suggested comet Encke in 1974 as the one that may be looked into for a possible space mission. "But right now we are not even looking at spacecraft for it."

NASA has also authorized studies of the advanced uses of lunar orbiters and of *Surveyor*. Other authorized Phase A studies: 1) concepts to support future *Voyager* missions to Mars, including active landers. 2) Application of solar electric power.

- **Pre-Phase A work**—Most pre-Phase A studies are under NASA headquarters contracts. JPL also has a little of the work in-house.

This year, stress is laid on the trade-off problem involved in specific missions. Answers are in terms of energy requirements, flight times and travel distances. Variables are in terms of trajectories for each mission: ballistic, gravity-assist ballistic, continuous low-thrust.

The missions themselves are determined on 1) bases of their probable scientific value, as enunciated by NASA scientific committee, and 2) engineering feasibility.

- **Pioneer**—Redirection of the *Voyager* program to eliminate the 1969 mission has given Ames Research Center increased hope for approval of its proposal for an *Extended Pioneer* to fill the space probe gap between 1968 and 1971.

Robert M. Crane, Ames assistant director for development, told M/R that while *Extended Pioneer* "is not an approved, funded program, we have been authorized to perform both in-house and contracted studies to investigate modest extensions of *Pioneer's* present capability."

Pointing out that there are no presently approved planetary or interplanetary probes between *Pioneer D* and the 1971 *Voyager* flight, Crane said: "We do feel *Pioneer* could help fill this gap in the forthcoming period of solar maximum when the interplanetary medium is of considerable interest in its agitated state. So we have proposed a program of additional spacecraft beyond *Pioneer D* as interplanetary probes."

Pioneer in its present configuration is a 141-lb. spacecraft to investigate the strip of space between 0.8 au and 1.2 au from the Sun. Prime contractor is TRW Systems Group.

Ames studies are directed at extending *Pioneer* capability to probe 0.5 to 0.2 au from the Sun or closer while avoiding becoming involved in any major development program. Investigation so far shows this is feasible. Actually, the spacecraft presently is capable of going considerably closer to the Sun, to within 0.5 au, according to Crane, with the 0.8 au limit representing the capability of the launch vehicle, not the spacecraft.

"It is an extremely versatile spacecraft with an excellent communication system and magnetic cleanliness that has never before been achieved, and it is very well suited for particle and fields type experiments in interplanetary space," he said.

Pioneer is spin-stabilized, with the spin axis normal to the plane of the ecliptic. As a result, the on-board instruments scan in the ecliptic plane and pass the Sun on every revolution, which is the ideal scan for measuring interplanetary magnetic fields, solar plasma, and solar and galactic cosmic rays."

To date, Ames has investigated *Pioneer* possibilities for more energetic interplanetary missions, looking into ways to increase the communications antenna gain to permit higher data rates and extend communication distance. It has considered alternate power supplies

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Type 10A2 Dual-Trace Unit	$725
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to permit operation inside the orbit of Mercury.

"We have small contracts out for supporting research and technology covering some of the more difficult technological problems associated with operating close to the Sun," Crane said. "These include contracts on communication systems, thermal control, stability of thermal coatings, magnetic field control—in all, we have about $800,000 worth of contracts involved in *Pioneer*-related research." Contract work includes investigation of changing from silicon solar cells to gallium arsenide solar cells or providing some kind of array switching for operation close to the Sun, study of multi-foil insulation, research into means of thermally testing the craft at solar intensities corresponding to 0.2 au, and a hardware contract for a solar sensor able to operate from 0.2 to 1 au. Ames has also studied a de-spun thermal shield, which adjusts the area of solar cell exposure as the mission nears the Sun, and Philco Corp. has considered a method of thermal control of the solar array by addition of reflective surfaces.

The *Pioneer* staff also is considering modifications necessary for operation farther than 1.2 au, to Mars and beyond, which would require redesign of the electrical power system. Beyond Mars, Crane believes a radioisotope power supply similar to SNAP 19 would be necessary. Actually, Crane points out, Ames is doing more investigation of *Pioneer* in-bound missions since the Goddard center already is concerned with out-bound missions.

Some of the specific solar missions being considered at Ames involve perihelions of 0.51 au, 0.4 au, 0.291 au, and 0.09 au. The trajectory approaching 0.4 au is for a spin-stabilized vehicle with 55 watts end-of-life power output, with solar cells bonded to the surface of the spacecraft. The 0.51-, 0.291- and 0.09-au trajectories are for a sun-oriented vehicle with 285 watts end-of-life power output, with solar cells bonded to panels attached to the craft. A design requirement is that the solar array provide a continuous power output, not falling below the end-of-life level, for the entire duration of these missions. While the possibility of varying the system duty cycle to fit the mission profile is not considered in this specific study, Ames nevertheless is keeping in mind the possibility since a saving in array area could be realized by matching the system power requirements to variations in the solar cell output as the spacecraft approaches the Sun.

Ames' work on *Extended Pioneer* is in two categories—first extending capability to operate at 0.5 au, secondly, determining the greater modifications required for the craft to operate into 0.2 au or in an orbit inclined as much as 20 degrees to the plane of the ecliptic—"one or the other of these," as Crane puts it.

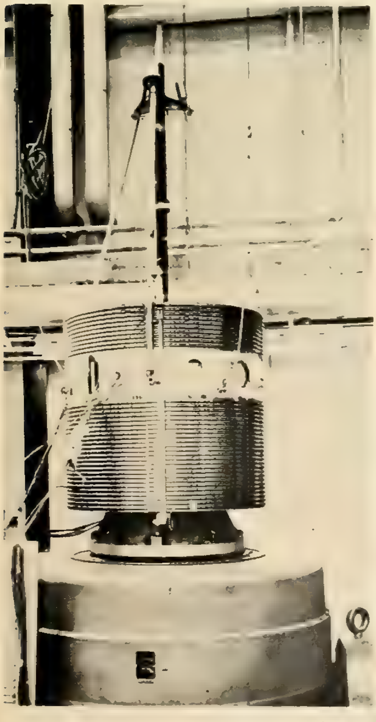
For launching at that inclination to the ecliptic, a polar launch would be required from the Western Test Range. Also required for this, as well as for the mission to 0.2 au, would be the *Atlas-Centaur,* plus a solid injection stage.

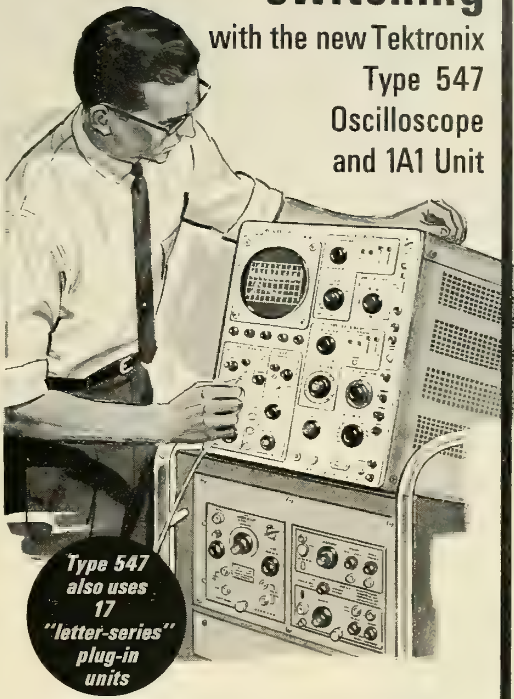
Although there are no mission studies beyond these at present, Ames does have supporting research and technology studies that will provide a technological input to still more ambitious missions for the *Pioneer* series. For instance, one study area is on the effects of a radioisotope thermal generator (RTG) power system on particle and fields types of experiments the spacecraft could perform.

Although there are no studies as yet for an *Advanced Pioneer,* the supporting research and technology studies, both in-house and on contract, support the concept. These include the RTG investigation and studies into thermal coatings and data handling. *Advanced Pioneer* would be a larger spacecraft to go even closer to the Sun or farther out, and it is a "big question mark," according to Ames spokesmen.

NASA will probably try to cast a space probe as near the Sun as possible. One method, needing only a moderate amount of energy, would be with a gravity assist from Jupiter. ■

PIONEER spacecraft in vibration test.





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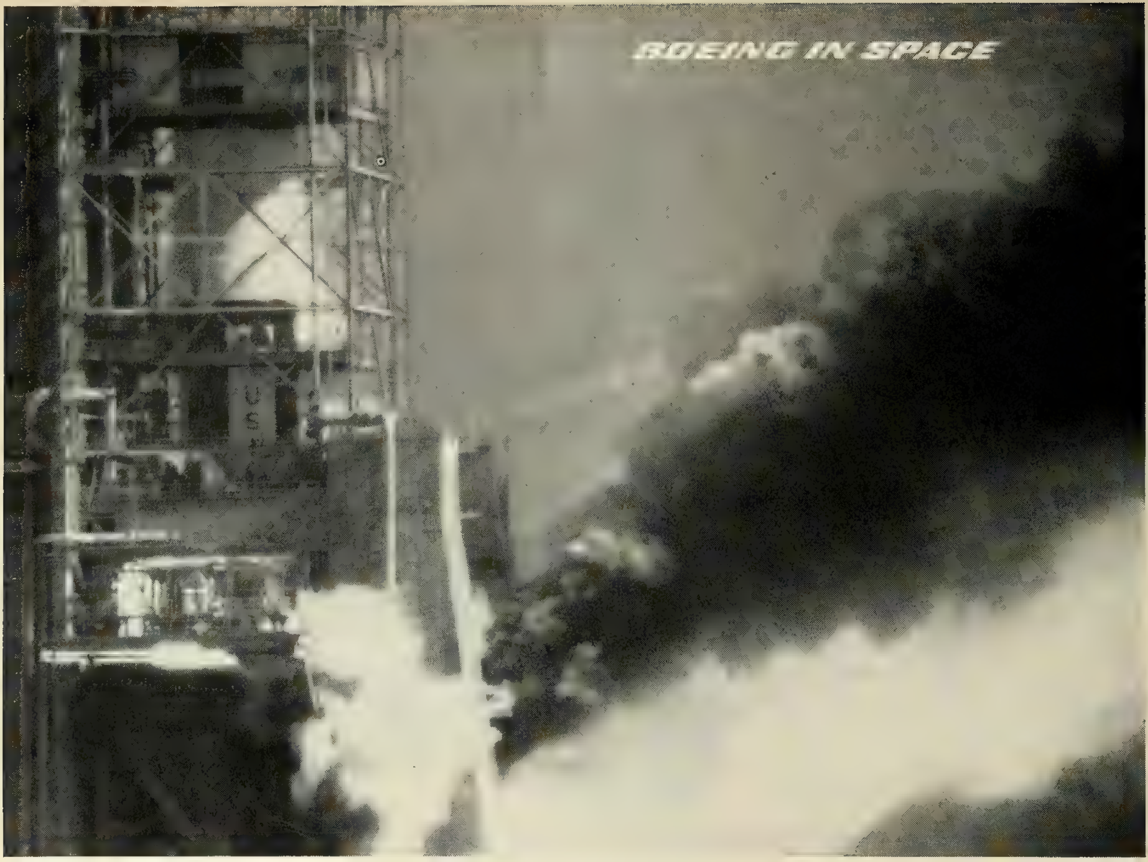
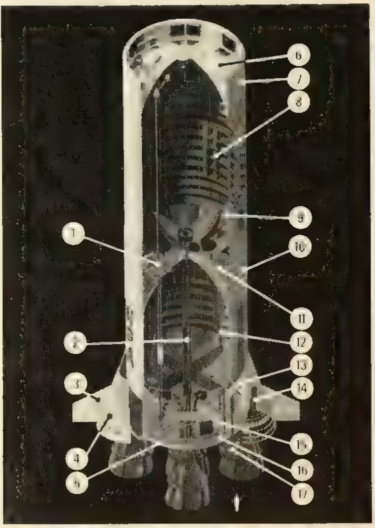


Smoke, steam and flame mark the successful first full-duration test firing of the world's largest rocket booster —Saturn V's S-IC first stage. All five Rocketdyne engines of the S-IC, shown firing simultaneously at NASA's Marshall Space Flight Center, are generating the most force ever produced by a rocket—7.5 million pounds of thrust, roughly equivalent to 160 million hp in flight.

NASA's Marshall Space Flight Center and Boeing are jointly developing and testing Saturn V's S-IC booster. Saturn V—tall as a 30-story building and weighing 3,000 tons — will launch men and equipment into earth orbit, lunar orbit and deep space probes. It will be able to launch 100 tons into earth orbit or propel several tons of instruments to Mars.

NASA's Saturn V will launch American astronauts to the moon this decade. **BOEING SPACE DIVISION**

Saturn V S-IC



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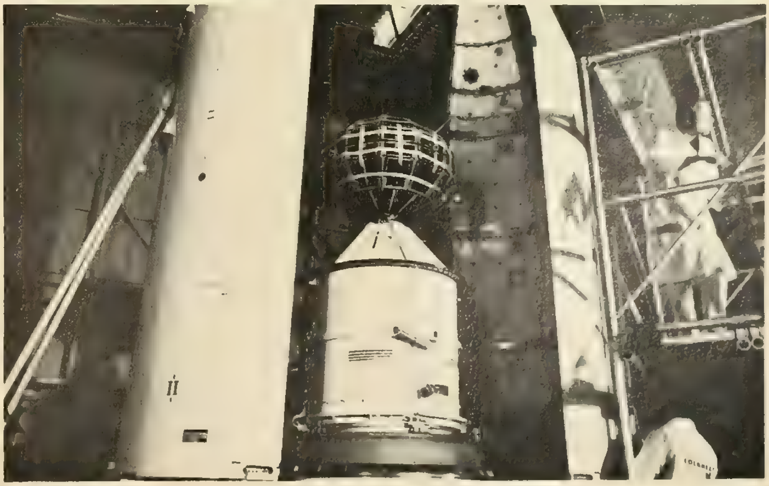
15. Center engine support
16. Lower thrust ring
17. F-1 engine

ESRO To Buy U.S. Launch Vehicle

Move will mark first fund exchange in cooperative projects; foreign experiments submitted for Apollo, Voyager programs



A REQUEST FOR PROPOSALS issued in Europe by the European Space Research Organization (ESRO) has made it clear that at least one of its scientific satellites will require the use of a U.S. launch vehicle.

Since the issuance of the RFP, ESRO and NASA have discussed the launching of satellites from U.S. sites on a reimbursable basis—launches that would probably require a vehicle in the *Delta* class.

This is the first time a foreign entity has taken clear steps toward purchase of a U.S. launch vehicle. Heretofore, in NASA's ever-widening program of cooperation in satellite projects with other nations, the space agency has always provided the total launch capability—vehicle, site, personnel and ground support—in exchange for sharing in the data provided by a foreign-built payload.

The move also gives U.S. industry its first opportunity to share directly in a foreign market that is slowly but steadily maturing.

Besides *ESRO II* and *ESRO I*, scheduled for launch on NASA *Scouts* in early and late 1967, respectively, the European consortium has plans to put into orbit a highly eccentric orbiting satellite *(HEOS-A)*, complementing NASA's *IMP* program to measure cislunar magnetic fields, cosmic rays and solar winds. ESRO is also considering a large astronomical satellite *(LAS)* complementing NASA's *Orbiting Astronomical Observatory (OAO)* series, and has tentative plans for still other satellites.

ESRO apparently could not wait for the European Launcher Development Organization (ELDO) to bring its *Europa I* launch vehicle to operational status. There is also some indication that *Europa I* will have considerably less lift

ABOVE RIGHT: Direct Measurement Explorer (DME) is fitted on vibrator in environmental test chamber. The U.S. satellite was slated for launch late this month aboard a Thor-Agena from the Western Test Range. RIGHT: Prototype of Canada's Alouette II. The topside sounder was to have gone aloft aboard the same vehicle with the DME.

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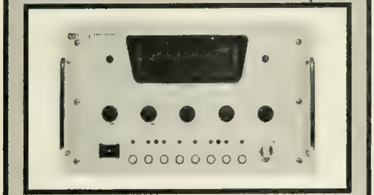

The DEI Bit Error Rate Monitor provides a means of comparing two serial NRZ data bit streams on a bit by bit basis. It accumulates the number of negative or positive comparisons over a bit interval selectable 10^3 to 10^7 bits or on a continuous basis. Provision is made for processing code forms other than NRZ. The number of bit errors (or bit matches) are presented on a visual digital display while simultaneously presented in BCD form as a printer output.

The BA-102 Series can be used in conjunction with PCM serial simulators to measure bit error rate of PCM processing systems. Operation is provided at bit rates from DC to 2 megacycles with data I/O threshold adjustable from +7 to −7 volts.

The power supply is self-contained and input/output connections are provided on both the front and the rear of the unit. A built-in delay to compensate for delay of the processing system under measurement is also provided.

For additional information write for Bulletin BA-102.

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capability than originally planned. Hence the interest in a U.S. booster.

- **Other avenues**—NASA officials point to these other possible future cooperative projects as among the most significant under the cognizance of the agency's Office of International Affairs:

—Proposals from other nations for experiments to be considered for Projects *Apollo* and *Voyager*.

—The possibility of NASA-French cooperation in Project *Eole*, the French meteorological satellite development program.

—The possibility of including other nations in the Inter-American Experimental Meteorological Rocket Network (EXAMETNET) that now embraces NASA, Argentina and Brazil.

—The possibility of the space agency sharing in data gathered in sounding rocket launches from a proposed equatorial site in French Guiana.

—"Attractive possibilities," according to NASA officials, for follow-on satellite projects involving nations with whom the space agency is already cooperating in such projects under existing agreements, plus what are termed "some interesting proposals" from nations not now participating in projects with NASA.

—Establishment of an ESRO ground station on U.S. soil.

The success with which NASA met in opening its observatory satellite program to foreign experimenters led to the decision to seek proposals for manned and planetary programs also. To date, 16 experiments have either flown or are scheduled to fly aboard observatory satellites.

- **Apollo/Voyager**—NASA is now considering experiments from two other nations for inclusion in Project *Apollo:*

1) A private Canadian company has proposed an atmospheric iodine-detection experiment to go aboard an Earth-orbiting *Apollo* spacecraft.

2) The University of Berne, Switzerland, has suggested an *Apollo* experiment to determine the light, medium and heavy elements in the solar wind.

Nine foreign experiments have been submitted for Project *Voyager*. Consideration of four of these for the *Voyager* lander has been postponed, but five others are in the running for the *Voyager* Mars orbiter:

1) A Canadian proposal for an experiment to investigate the Martian atmosphere.

2) A French proposal for a polarometric study of the Martian surface from an orbiter.

3) A Swedish entry to study the ions and electrons in interstellar space and in the Martian atmosphere.

4) Two experiments from University College, London, to study the Martian atmosphere and ionosphere.

NASA officials are optimistic that some of these experiments will ultimately be selected for the *Apollo* and *Voyager* programs, principally because of the high acceptance rate of foreign experiments for the observatory satellite projects. They estimate that it costs the experimenter about $250,000 to bring his package to flight readiness. This works out to a potential of nearly $3,000,000 in foreign experiments for *Apollo* and *Voyager*, in addition to $4,000,000 in non-U.S. scientific packages already accepted for the observatory satellites.

- **Moscow and Bonn**—In addition to these possible future developments, NASA hopes for early implementation of existing agreements with the Soviet Union and West Germany.

Daily two-way transmissions of weather data now take place on a Washington-to-Moscow link established under a memorandum of understanding reached by representatives of NASA and the USSR in June, 1962. A second agreement, signed this October, provides for a joint review of research in space biology and medicine in the two countries.

But there has been no realization yet of the prime objective of the June, 1962, agreement between NASA and the Soviet Academy of Sciences—the continuous exchange of cloud-cover data obtained by meteorological satellites. NASA officials say they expect the Soviet Union to launch a meteorological satellite for this purpose "within a few months." If this happens, it will be the first known launch of a weather satellite by the Russians.

First steps toward implementing the July agreement between the space agency and the Federal German Ministry for Scientific Research (BMwF) have already been taken with nomination of the persons to form the working group within both agencies. BMwF has named the Space Research Society (Gesellschaft für Weltraumforschung) to manage the program, designated Project 625A.

Primary objective of the U.S.-West German scientific satellite program is a study of the Earth's inner radiation belt. The timetable calls for a 1968 launch of a German satellite into a polar orbit. The launch would take place from the Western Test Range on a *Scout* vehicle provided by NASA. As is the case with all the space agency's cooperative international programs, results of the experiments would be made available to the world scientific community.

- **French balloons**—NASA's role in France's Project *Eole* would probably be to provide the launch capability, including a *Scout* vehicle. Possible cooperative execution of the program is now

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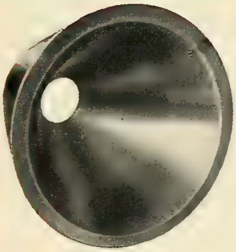

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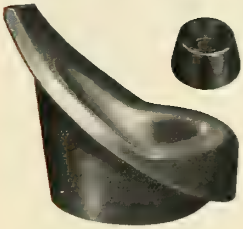

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being discussed by space agency representatives and officials of CNES, France's space agency.

The French have already outlined the program to the world Meteorological Organization and the international Committee for Space Research (COSPAR). It calls for launching hundreds of super-pressure balloons over a two-week period. Each balloon would carry a power supply and transponder.

Purpose of *Eole* is to get a complete set of observations of the troposphere at one level extending around the globe from the equator to 60° south latitude. The balloons would remain at a relatively constant altitude. They would measure the velocity and direction of the wind, plus local pressure and temperature. Then France's *D-3* satellite would be launched into a nearly equatorial orbit to locate, identify and interrogate each balloon.

The program is a stride toward global, long-range meteorological forecasting. NASA will share in the data yielded if it is agreed that the space agency will supply the *Scout*.

- **Sonde network**—France also figures in international efforts toward obtaining a world-wide equatorial sounding rocket launching network. She may establish a sounding rocket launch site in French Guiana. NASA does not, of itself, have access to equatorial launch sites, although it does have an agreement with India's Department of Atomic Energy (DAE) to conduct a program of joint space research—investigations in aeronomy, ionospheric physics and magnetic fields. The U.S.-Indian experiments will be launched from DAE's Thumba Equatorial Rocket Launching Station (TERLS) near Trivandrum.

Such a site in French Guiana would add significantly to important equatorial meteorological data, which is of interest in establishing world-wide atmospheric profiles. NASA is alert to any possibility to cooperate with France in the proposed Guiana endeavor so that this nation might share in data gathered by the sounders.

Preliminary site preparation is under way for an ESRO ground station near Fairbanks, Alaska. It will be a data-acquisition (telemetry and command) facility, and the first foreign station in the U.S. It will also be compatible with NASA's Minitrack network. Since U.S. law prohibits a foreign national to transmit from the United States, a U.S. contractor will carry out the actual command transmissions.

An amendment to the privileges and immunities laws is required to facilitate customs clearance for ESRO personnel and equipment to be used at the station. The amendment passed the House in the first session of the 89th Congress, but was shelved by the Senate in pre-adjournment action. NASA officials do not anticipate any opposition to the amendment, however. They have been gratified to work with ESRO in the endeavor, since the space agency has been given access to tracking and data-acquisition stations all around the globe.

- **EXAMETNET**—Bilateral agreements have already been signed between NASA and Argentina and NASA and Brazil aimed at establishing the Inter-American Experimental Meteorological Rocket Network (EXAMETNET). Purpose is to "contribute to studies of atmospheric structure and behavior in the southern hemisphere and to help explain atmosphere differences and similarities between the northern and southern hemispheres."

NASA officials expect that all three signatories will be launching sounding rockets in the program by Jan. 1. NASA sounders have already been sent aloft from Wallops Island, Va., to test instrumentation that might be used in EXAMETNET.

Wallops is the U.S. launch site in the network. Argentina's Chamical range in La Rioja province will serve as that nation's first EXAMETNET site, and Natal, located on the Atlantic coast of Brazil in Rio Grande do Norte, is Brazil's EXAMETNET launch site.

Argentina may also activate launch sites on the Palmer Peninsula in Antarctica, and at Comodoro Rivadavia on the southeast coast of Chubut province.

In addition, Canada and Mexico have shown interest in the EXAMETNET concept, and NASA officials expect them to participate in the program. Mexico has proposed Guaymas on the Gulf of California as its launch site, but NASA spokesmen say they would prefer that the Mexicans chose a site farther east—possibly in Yucatan—to narrow the slice of atmosphere covered in the program.

Ft. Churchill on the west coast of Hudson Bay could conceivably be the Canadian launch site, but again, space agency officials would like to see establishment of a more easterly location.

NASA officials report that Argentina is particularly enthusiastic about EXAMETNET. Sounding rockets are among the more useful space pursuits open to nations with budgets attuned to lower levels of effort. Only the narrow strip of Chile separates Argentina from the vast expanse of the South Pacific.

There are no meteorological stations west of Chile that could provide fishing fleets with information on approaching storms, or give planters in a heavily agrarian economy data on approaching weather conditions. Argentine fishing fleets now suffer heavy storm losses that could be prevented with implementation of the EXAMETNET idea.

EXAMETNET, according to NASA spokesmen, is an early step toward establishing a skeletal polar meteorological data-gathering system. The Indian sounding rocket range at Thumba, combined with other equatorial sites such as the one proposed in French Guiana, represents a move toward realization of routine equatorial sounding rocket weather sampling on a scale similar to that now accomplished with balloons.

NASA hopes that future agreements similar to those now existing in EXAMETNET will fill out the skeleton, providing a mature system with mutual benefit to all participants.

Existing bilateral agreements provide for the U.S. to launch 14 scientific satellites, including *ESRO 1* and *ESRO II*, that have been instrumented, and in all but two cases engineered abroad. The next such launch will be France's *FR-1*, slated next month aboard a *Scout* from the Western Test Range.

FR-1 is built by CNES and will measure electronic and magnetic components of utlra-low-frequency radio emissions from a near-polar, 800-km orbit.

Four satellites have already been launched under the terms of these agreements (one each for Canada and Italy and two for the United Kingdom). Experiments conducted have included investigations of ionospheric, energetic particle and atmospheric phenomena.

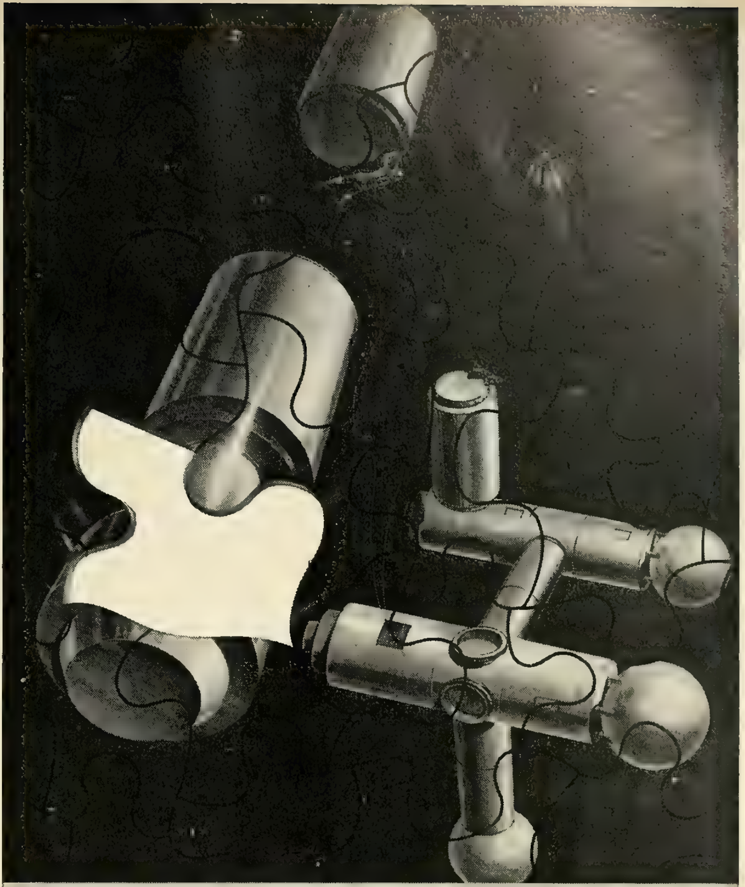
Canada's *Alouette*, launched Sept. 29, 1962, by NASA on a *Thor-Agena*, is often described as the most successful scientific satellite launched to date. The topside sounder is still transmitting, and its success blazed the trail for four more U.S.-Canadian satellite launches. *Alouette II* may have achieved successful orbit by the time this issue is published. Like its predecessor, *Alouette II* will sound the ionosphere from above to measure hour-to-hour electron densities.

Three launches by NASA of Canadian *ISIS (International Satellite for Ionosphere Studies)* are also scheduled, all in 1967.

The first two phases of Italy's *San Marco* satellite project are complete, and the final step, launch of a *San Marco* satellite aboard a NASA-furnished *Scout*, is set for either 1966 or 1967. The launch will take place from a platform in the Indian Ocean. The satellite is designed to carry out both atmospheric and ionospheric studies.

The United Kingdom's *Ariels I* and *II* scientific satellites were launched April 26, 1962, and March 27, 1964, respectively. *Ariel III* is scheduled for early 1967 launch.

At least one of these nations has indicated to NASA that it is interested in follow-on cooperative scientific satellite projects. ■



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Hypersonic, Planetary Flight Pace Effort

Hypersonic ramjet to fly aboard advanced X-15 at 6,000-8,000 fps; manned Mars mission requirements to become space 'standards'

NASA'S OFFICE OF Advanced Research and Technology (OART) has requested a total of slightly more than $400 million in research and development funds for the next Fiscal Year, but this is expected to be reduced by agency and Budget Bureau officials to about $300 million.

Among the major new projects included in the request is the *Orbital Scanner Satellite,* a space power technology satellite, a delta-winged version of the *X-15* rocket plane, the hypersonic ramjet engine, a series of electronic system flight tests and a step-up in radiation attenuation measurements (RAM) flights.

Of these projects, only the delta-winged *X-15*, the *Orbital Scanner Satellite* and the hypersonic ramjet engine are expected to receive substantial new funding in the Fiscal Year 1967 budget.

A host of other small research programs will also be funded as the hypersonic *X-15* and the Manned Mars mission point the way to OART's future research tasks.

The number three *X-15* is slated for conversion to a delta-wing design in an attempt to verify hypersonic flight concepts on a large scale at NASA's Flight Research Center at Edwards AFB, Calif. Although principal purpose of the *X-15* program action is not to develop a first-stage reusable booster, its mission of identifying needed technology over a broad range will be a major step toward that end.

The delta-wing conversion will cost only a few percent of a new hypersonic research vehicle and will cover some of the prime elements of needed research. The platform has been selected by most aerodynamics researchers as the one with greatest advantages for hypersonic flight. Investigated will be large-scale flap controls, tip-fin interference effects, performance prediction methods and handling qualities of hypersonic craft.

• **Propulsion considerations**—Propulsion for the delta-wing conversion will be provided by the vehicle's normal rocket engine. For a separate propulsion research project, NASA already has approval for modification of the number two *X-15*.

Number two will be fitted with an 18-in. convertible ramjet engine designed to take the vehicle to the speed regime of 6,000-8,000 fps for investigation of that range before studies continue to a velocity of 12,000 fps.

Conversion of this vehicle will be the product of numerous studies spanning the past five years revealing the possibility of cruise flight at these speeds. Possible applications include long-range transport or military reconnaissance, but no end use has been specified for the information gained. NASA is attempting to conduct broad-spectrum studies to make general application possible.

In most cases studied, large hydrogen-fueled air-breathing engines are required. Hypersonic vehicles inherently have lower aerodynamic and structural efficiency, but some of these limitations can be successfully offset with liquid hydrogen as a fuel.

Among the problems expected by OART during the course of development are those associated with boundary layer control, surface friction, and aerodynamic control. About five minutes of stable hypersonic flight will be obtained during each of the tests, which will use only internal fuel tankage.

Altitudes reached by the vehicles during their flights will range up to 80,000 or 100,000 ft., and a small extension of the present *X-15* range from Wendover AFB to Edwards AFB will be required. The speed limitations of Mach 6 to 8 are set by materials characteristics.

Among the steps taken by OART to get necessary data will be the installation of lightweight materials in place of some heat-sink types, and to distribute these lightweight versions within the structure of the vehicle instead of making them externally mounted test panels.

• **Funding the effort**—Initiation of the program is expected in Fiscal Year 1967, assuming approval is forthcoming, but OART officials say it would be about 10 years before anybody could apply the anticipated data to a firm hypersonic cruise vehicle design. Therefore, FY'67 is not a do-or-die year for beginning the research.

North American Aviation is not the sole candidate for doing the conversion work. NASA would like an industry-wide competition on it. Agency officials conceded, however, that NAA is the most logical choice, inasmuch as it designed and built the original craft.

OART says it would be surprised if the conversion work for the delta-wing

MODEL of delta-winged X-15 hypersonic research craft.

X-15 costs less than $15 million, and the total cost of all work connected with the project might be as high as $25 million.

Extent of the "bare modification work" OART feels will cost at least $15 million has not yet been established, but the fuselage stretch involved would range between 2 and 10 ft., depending on the final configuration agreed upon and the performance characteristics desired.

In addition to the delta-wing and ramjet conversions of the *X-15*, OART and Langley Research Center are looking into the possibility of a ramjet-powered *X-15*, in contrast to the passenger-only ramjet, but feel this is too great an extension of the present basic airframe. Langley also has a passenger version of a ramjet under consideration for an *X-15*, but this is still in the talking stage.

Meanwhile, the ramjet engine is under study by Marquardt, General Electric and Garrett Corp., and results are expected by the end of January, with contract award due in June or July.

The convertible ramjet can be used in either subsonic or supersonic combustion modes to operate from supersonic into the hypersonic flight regime. The flight research center is hoping to install an improved XLR-99 rocket engine in the number two *X-15* for the ramjet research program.

From a given go-signal, it is expected that 6 to 8 months will be required for studies of the delta-winged *X-15*, and about 18 months of actual modification work to get the vehicle flying. It could be done faster, but OART feels some essential structures research would have to be sacrificed, thus forcing retention of some of the undesirable heat-sink materials.

MARS MISSION

"If you can make it to Mars and back, you can make it anywhere," is a current attitude of OART's Mission Analysis Division, working out of Ames Research Center. MA division, charged with a far look into what technology will be required after *Apollo*, has concluded that Mars missions will set the pace for the entire solar system.

Earth-entry velocities for missions returning from the red planet will be among the highest calculated for the entire solar system, thus leading to the selection of Mars as a guideline. The reason for Mars being the most critical of the planets for space travel is related to the tendency to select trajectories that go around the Sun the same number of times as the Earth does when travelling to the nearer planets, while selecting those that go around the Sun once less than the Earth when travelling beyond Mars. Researchers at MA division say this situation became clear only recently after they had studied trajectories for all the planets. Following this disclosure, it has become a rough rule of thumb that the technology required for a complete manned reconnaissance and landing on Mars, with return, will very likely suffice for all the other planets.

Finding such common denominators is a key responsibility of the Mission Analysis Division, formed about 10 months ago at the Ames Research Center. The division looks 15 to 20 years ahead in an attempt to pinpoint the technology required for advanced space missions during that period, but does no development work. The numerous mission studies undertaken by MA division or funded by it are designed to probe for requirements, not to generate missions.

As an example, two contracts recently funded on a parallel basis to study unmanned systems for examining the Martian environment were not expected to point to new probe designs. Instead, they were to see what "fell out" in the way of requirements for sensors. Results have not been released, but it was noted that a better knowledge needs to be gained of the micrometeoroid environment before such a mission is planned. Other studies have similar objectives and involve funds ranging from $100,000 to $200,000 each.

Contracts include such titles as: study of heat shield requirements for manned Mars landings and return missions; study of design considerations for reusable launch vehicles; study of deep-space monitor communications systems using a single Earth satellite; and a study of manned vehicles for entering the Earth's atmosphere at hypersonic speeds.

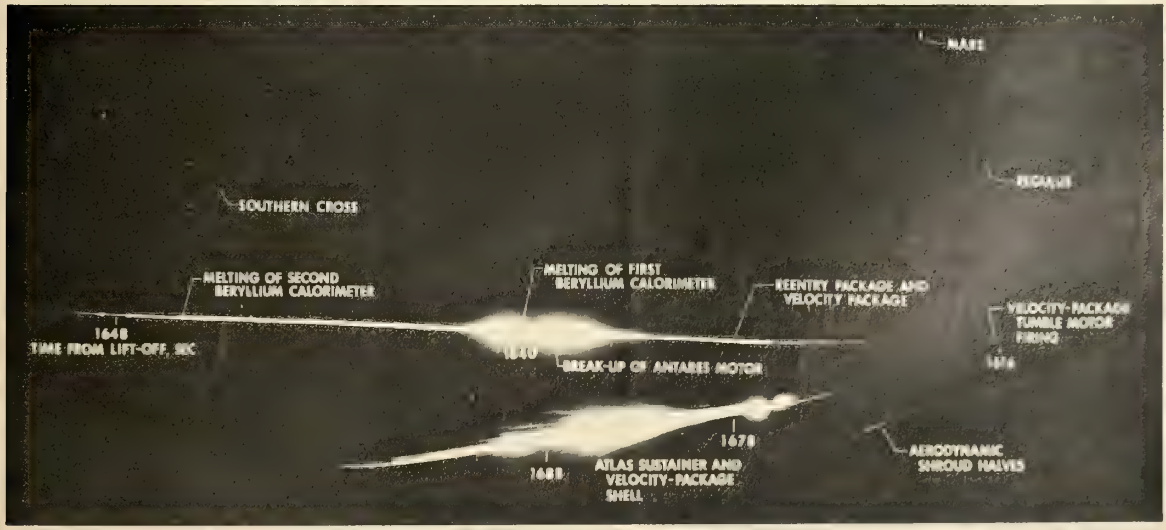
BIOTECHNOLOGY

OART's Biotechnology and Human Research Division is currently working 5 to 15 years ahead of today's programs. The myriad biotechnology research going on now is, as far as possible, not duplicating any work being done by the military. Nor will B&HR undertake any clinical work, although it lends support to other efforts.

The B&HR division works in four groups: human research and performance, man-systems integration, life-support and protective systems, and small biotechnology flight projects.

One of the division's most noteworthy hardware experiments underway is the life-support system now en-

PROJECT FIRE re-entry profile. Speed of some 25,400 was attained here, and OART plans tests at 50,000 fps.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1688
ATLAS SUSTAINER AND VELOCITY-PACKAGE SHELL

tering initial operation at Langley Research Center. This system, designed to support spacecraft crews for up to 90 days, is in final checkout and partial operation now. After the holidays, it will become a closed system and OART expects that it will be tested with human occupants by next summer.

• **Food regeneration needed**—On a more ambitious project, a one-year life-support system, the same basic technology will be used, but without the 90-day re-supply operation. This system will attempt to get food regeneration included in the closed cycle, in contrast to the 90-day system that regenerates only air and water.

B&HR points out that even if such missions as a manned expedition to Mars should not be realized, long-duration life-support systems will be required on the Moon. Thus far, life-support systems have been reduced from 32 to 16 lbs. per man day of expendables. Further work is aimed at reducing the weight, increasing reliability and extending the duration.

Another significant but as yet unapproved experiment for which OART has conducted preliminary ground tests is one in which two squirrel monkeys would be put into orbit for six months to determine prolonged effects of weightlessness and other conditions.

The monkeys would be unrestrained and would be in a capsule sent into space with a manned spacecraft. Once in orbit, the astronauts aboard the spacecraft would check out the monkey capsule before pushing it into its own orbit. OART would then retrieve the monkey capsule after six months for detailed examinations of its occupants to back up data telemetered during the flight.

The experiment would help determine problems in orientation for the unrestrained subjects, as well as effects of weightlessness.

One of the most sought-after answers in OART's biotechnology program is a means to accurately and reliably measure stress levels. Although fatigue can be measured, OART's biotechnologists are not content because high motivation levels among astronauts can partially overcome exhaustion effects.

Stress, however, is a more dangerous factor because no amount of motivation can overcome it completely. Human miscalculation while under stress after a long mission could wipe out everything that might have previously gone well.

• **Measuring stress**—The most promising current approach to the measurement of stress is a reading of the vasopressin level in the blood. Vasopressin is a neurohormone released into the blood by a triggering action of the brain when a human is under stress. To a point, the release of vasopressin is proportional to the level of shock or stress being experienced by the subject, whether the stress is physical or psychological.

Although the most promising apparent approach, the vasopressin measurement is not yet on solid enough research ground to warrant anyone's becoming committed to it.

Meanwhile, at the Flight Research Center at Edwards AFB, NASA is getting cooperation of the Air Force in instrumenting test pilots to determine the physiological effects of stress. Wearing small instrumentation kits fed medical data via pasted-on electrodes, a pilot undergoing exacting and highly regimented flights can provide much basic material for the OART studies.

OART plans to use a micro-electrode device developed by an Italian physician in an effort to better understand weightlessness. The device is capable of tapping the signal impulses from a single nerve and will be used to conduct research on the otolith of the inner ear.

The otolith, a gravity-dependent organ, will not react to weightlessness, yet is a critical element in balance and orientation. An experiment involving the micro-electrode is approved for an early *Apollo* flight.

Other vestibular work being carried out under OART auspices will also probe weightlessness. The rate of rotation and other variables in generating an artificial gravity environment are being studied through use of gas bearings permitting test subjects to walk on walls. One facility carrying out such work is the Navy School of Aviation Medicine at Pensacola, Fla., while NASA's Langley Research Center is trying to apply mathematical models to the vestibular apparatus under force fields.

• **Cabin atmosphere work**—Spacecraft atmosphere is being researched by OART in an attempt to determine how long NASA can safely provide a one-gas oxygen-breathing atmosphere for astronauts. The B&HR division, although acknowledging that pure oxygen leads to greatly simplified life-support systems, is aware of possible tissue damage from prolonged exposure. The threshold of this danger point is now being sought.

Animal experiments involving increased pressures and exposures are being carried out, as are studies to determine the true inertness of nitrogen. B&HR scientists are afraid that nitrogen might have some subtle but vital benefit for the body and that removing it completely from a spacecraft breathing supply will result in unforeseen trouble.

In order to anticipate the need for cooling astronauts during periods of increased activity, B&HR has a project

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under way to measure the increased oxygen intake of an astronaut, and thus begin cooling the space suit before the heat commences.

Bacteriology enters into the B&HR program in an effort to determine the fine points of host-parasite relationships so that normally beneficial bacteria found in human intestines do not undergo an unforeseen and dangerous change in the space environment.

Spacesuit work is centered about convoluted joints in an attempt to make suits less restrictive of human movement in certain critical positions. The emphasis is on simplicity, and possible integration of a propulsion unit within the suit.

PROPULSION

Money for development of the 260-in. solid propellant rocket is as uncertain for the coming fiscal year as it was for the past year. With the final firing under present funding slated for February, backers of the program are hoping to get another $20 million but feel prospects for this are slight. But hopes go beyond this.

OART's Propulsion Division sees the future of the big solids entwined with advanced liquids for high cost-effectiveness and recoverability. The division is currently working on improvements for existing propulsion systems, and points out that almost any space payload boosted in the next 10 years will be handled by present boosters. The first anticipated use of a really new booster system is after 1975, which accounts for *Apollo* programs plus R&D time plus other delays. Everything before that time will be launched by boosters now being flown.

The envisioned booster beyond *Saturn V* for the manned planetary missions is called "The Blockbuster" and utilizes both solid and liquid propellant rockets. It could handle lunar payloads of hundreds of thousands of pounds if such a capability was necessary, and would be the vehicle required for a manned exploration of Mars. Availability is expected sometime after 1978.

With recoverable solid rockets, variable in number according to the mission, and a liquid propellant rocket core, the vehicle would have good cost-effectiveness and a favorable mass fraction.

Fluorine is seen as a good bet for upper stages in the field of advanced liquid propellants, but ground hazards preclude its use for first stages. It might be competitive with nuclear-powered rockets for some space applications, especially in the smaller stages, and OART is studying these.

Hybrid rockets seem promising for future communication satellites and

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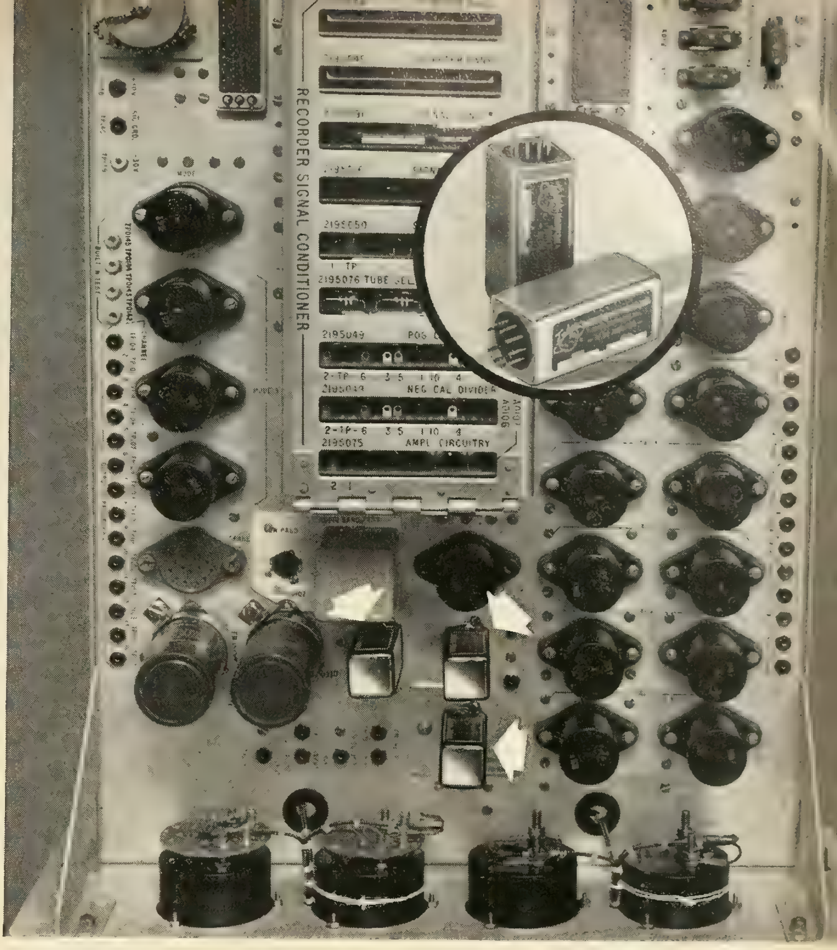

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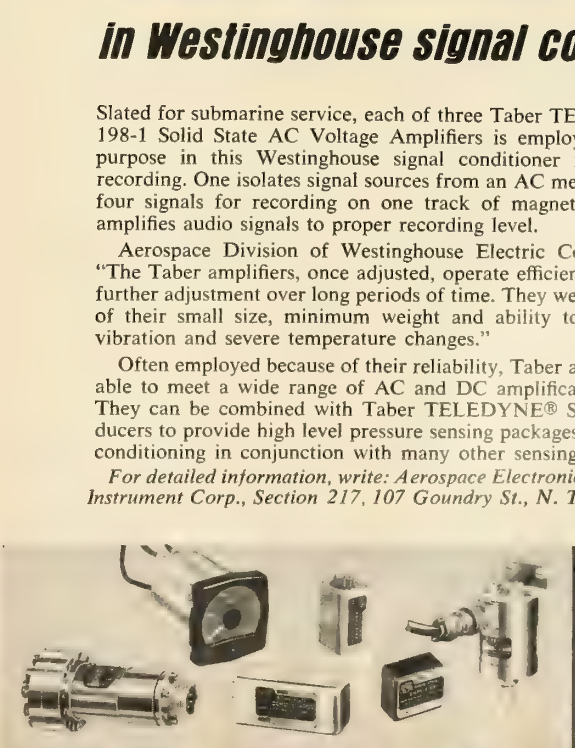

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scientific payloads because of their relatively low cost, flexibility for re-start, safety and simplicity. OART sees the hybrid useful only for unmanned vehicles because it out-performs the solid rocket and is cheaper than a combination of liquids and solids. Research work is aimed at defining its missions and determining its general characteristics.

SPACE VEHICLES

Possibility of sending an extremely large *Pegasus*-type vehicle to the vicinity of Mars to investigate the micrometeoroid danger is being considered, on the basis of preliminary data. Skin thicker than 50 mils would be used for gathering data over 10 months in the asteroid belt beyond Mars.

The project is now under study both in-house and with some contractors, and would call for 4,000 to 6,000 sq. ft. in a directional mode. The payload would feature improved instrumentation and could be launched with a *Saturn IB* or *Saturn V*. The vehicle has been neither named nor officially approved, but the wealth of previously unavailable data provided by *Pegasus* has spurred optimism for approval of a follow-on to expand the knowledge.

Re-entry vehicle developments include a flight test of the *M-2* lifting body vehicle early in December, and the possibility that future versions might be powered by an XLR-11 rocket engine of the type that powered the early *X-15s*. Variable geometry may also play a role in future designs of the lifting body vehicles, according to OART, and hypersonic flight will be tried. A version of the vehicle may also see future use for returns from planetary missions, for which the weight and geometry would again be altered.

In a related program to check out re-entry velocities and materials, OART plans to fire materials specimens at re-entry speeds up to 50,000 fps with *Scout* and other boosters. There is very little reliable data on turbulent heat transfer in the velocity range from Mach 10 to 25. There is also the desire to develop a standard flight test system for high speed re-entry, and this may involve *Scout*.

Plans are also under consideration to construct a VLF antenna about three miles in diameter in space, using composite materials. Such an antenna would weigh about 20,000 lbs. and would be used for studies of the universe.

ELECTRONICS & CONTROL

An electronic techniques and components program (ETC) is the core of OART Electronics and Control Division effort on new developments. The recently established ETC program is expected to double annually, and is not a separate organization. It forms the root source of information on new research for the E&C division's four branches, and fills a need that NASA feels for its own research group.

One of the key projects now in the division is *Scanner*, an attempt to prove the validity of some atmospheric models and find a permanently definable point of reference for determining the Earth's horizon. Only a couple of absorption bands are stable enough to be used. The CO_2 band at 14-16 microns seems best, and *Scanner* will specifically look at the 14.85 micron line. The band changes somewhat with variations in climate, but is still considered a stable point of reference. Also observed will be the 20-40 micron water vapor line.

From data obtained through the horizon-sensing equipment, an accurate center-of-Earth point can be calculated for orientation. First two launches will be ballistic shots from Wallops Island, Va., in the spring, and phase one studies are now under way for *Orbital Scanner* to continue the investigation.

Thin-film vapor-deposited solid-state devices are under study by ETC as field effect devices, but their short life span is a problem. Aging of the product is caused by unknown influences. Similar devices in theory that do not work on the field effect are not yet considered feasible, mostly because of their vulnerability to radiation.

- **Laser studies**—Laser applications under consideration include real-time television from Mars and other deep-space communications uses. OART estimates that 5 to 8 million bits per second would be required for scientific quality photos from Mars.

Laser and optical technology offer the best prospects for meeting the anticipated requirements, since it would take about a 30-ft. antenna and power in the kilowatt range to get commercial quality photos with conventional equipment. Lasers could probably do the same job or better with a small dish antenna and tens or at most hundreds of watts.

The prime difficulty with the laser is its demand for pointing accuracy. From Mars, it would be necessary to point the antenna within 0.01 arc/seconds, or the angle subtended by the human eye at a distance of 30 mi.

Data compression is another area crying for improvements in current methods. OART says presently orbiting payloads send back to Earth enough data each day to fill three or four full-size textbooks. Ways are being studied to compress this volume to sort the wheat from the chaff, because future space probes will be capacity-limited in channels and because the volume of data needs being digested by an already choked system.

One of the latter is called "previous element coding," which boils down to an electronic ditto mark for all but the first of a series of identical items of information. This approach might yield a 10:1 improvement through elimination of redundancy in telemetry bits.

BASIC RESEARCH

Supplying the "money in the bank" for all the previous efforts described in OART programs is the Basic Research Division, least discipline-oriented of OART's eight technical divisions.

In materials research, the search is on, as it is elsewhere, for high-temperature properties capable of withstanding extreme re-entry velocities. Ablation materials are most promising, with graphite and plastics families out front, but OART declines to specify compositions. Instead of knowing quite a bit about ablation, OART says it is at the very beginning of understanding this field, and missions to Mars and the planets will accentuate the need.

Superconductors capable of retaining this property under high-gauss magnetic fields have yielded to normal conductivity at levels as high as 40,000-50,000 gauss, and OART wants to push this to at least 100,000 gauss. Niobium-tin is the most successful metal thus far to fight off normal conductivity levels under magnetism.

In areas of low-friction materials, some self-lubricating metals have been found, and at present OART is near its goal of a metal that will retain friction-free characteristics at temperatures as high as 2,200°F, and has found the subject in the calcium fluoride family.

Seeking some "strange objectives," the research division hopes to be able to supply basic answers to questions that will be asked in a decade or more. Few of its projects are aimed at present problems, although many of them can apply at almost any time.

PROGRAMS & RESOURCES

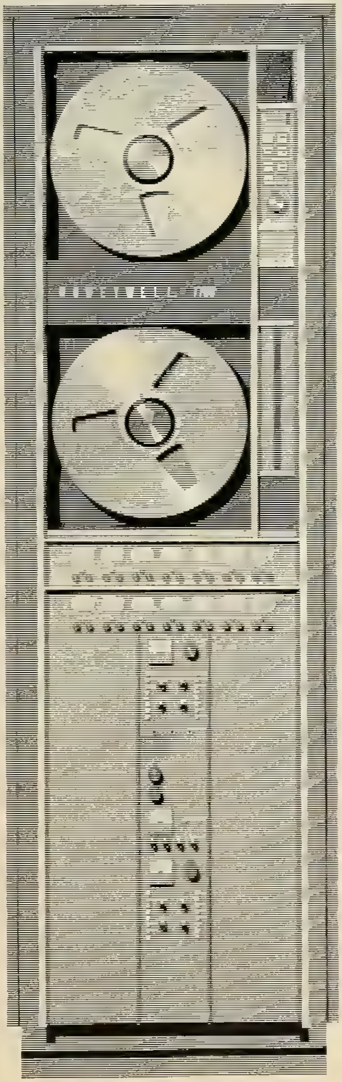
The division within OART that maintains coordination among the eight technical divisions also has a budgetary capacity in that it has a hand on the purse-strings and can recommend action on funding requests. The Program and Resources Division also has responsibility for publication of the technical data yielded by OART's work.

Carrying out analysis work on projects throughout OART, the P&R division sometimes recommends action to reduce duplication, cut costs or handle a problem more efficiently. The division has a major role in assuring the balance and pertinence of research efforts.

In a planning sense, the P&R division looks into the near future for upcoming requirements in the same manner as the Mission Analysis Division looks over the long-range view. ■

The Honeywell 7700 introduces these four significant advances in analog magnetic tape instrumentation:

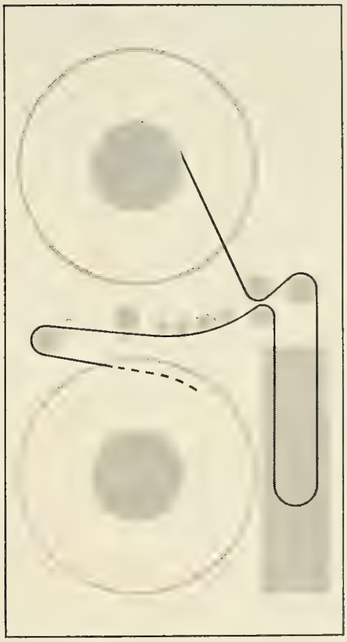
TIME DISPLACEMENT ERROR—Timing errors between record and playback can originate in dimensional changes in the tape caused by temperature, humidity and tension variations as well as differences in tape speed between record and playback. These effects have been minimized through use of a tape-controlled servo on the playback mode. Until now, however, high inertia systems could only reduce instantaneous timing errors to about 1 millisecond. The new Honeywell 7700 low inertia, high-response servo reduces this error to 1 *microsecond* at 120 inches per second.



FLUTTER—In the past, flutter has been reduced by use of high inertia drive systems which lose their effectiveness at low frequencies and low speeds. The high-response servo in the Honeywell 7700 virtually eliminates flutter below 100 cps and holds wideband flutter below 0.25% from DC to 10KC at 60 ips.

DYNAMIC SKEW—If data on two or more channels are to be compared, it is essential that varying time differences between channels caused by dynamic skewing of the tape be reduced. The use of vacuum column isolation and a 13-inch edge guide ahead of the record-playback heads reduces dynamic skew in the Honeywell 7700 to approximately one-third of that in state-of-the art analog systems.

SIGNAL/NOISE RATIO—Noise caused by electronics, tape and the tape transport can mask small amplitude data changes. Efforts to improve linearity, drift and other parameters are fruitless if a high percentage of noise is present. The Honeywell 7700 will produce signal-to-noise ratios as great as 48 to 52 db rms. This is a 2-to-1 improvement over the 40 to 44 db noise found in other FM systems.



The Honeywell 7700 is an 80 KC FM-640 KC Direct system built specifically to preserve the quality of your most critical data.

For complete specifications, call a scientific field representative at your nearest Honeywell office, or write Mail Station 402, Honeywell, Denver Div., Denver, Colo. 80217. In Canada: Toronto 17, Ontario.

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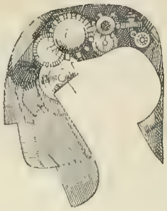
Circle No. 4 on Subscriber Service Card

WHERE CAN MAN GO...IN R & D?



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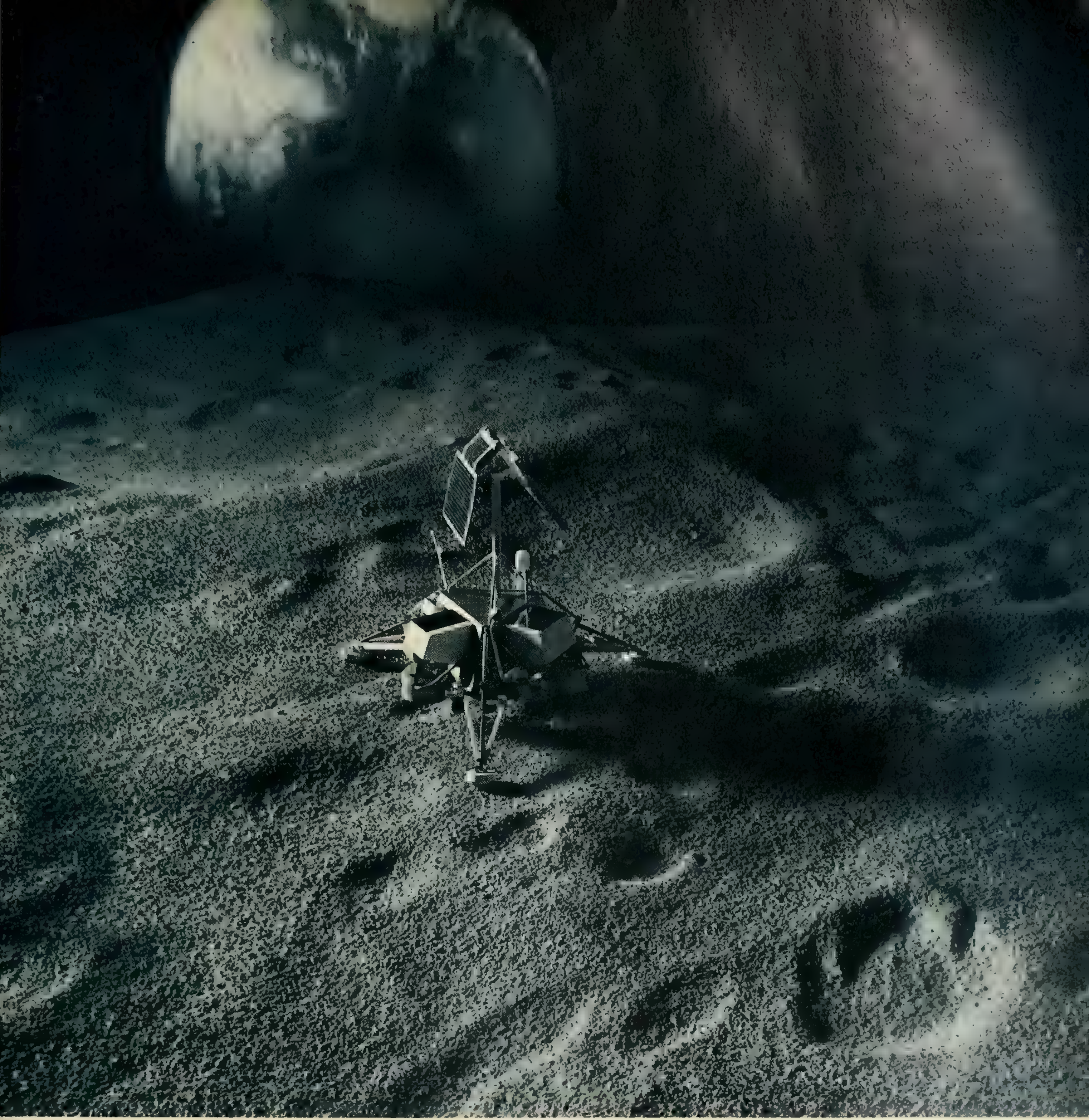

SURVEYOR model rests on lunar surface model constructed from information supplied by Ranger VII.

PART III

THE MANAGEMENT STRUCTURE

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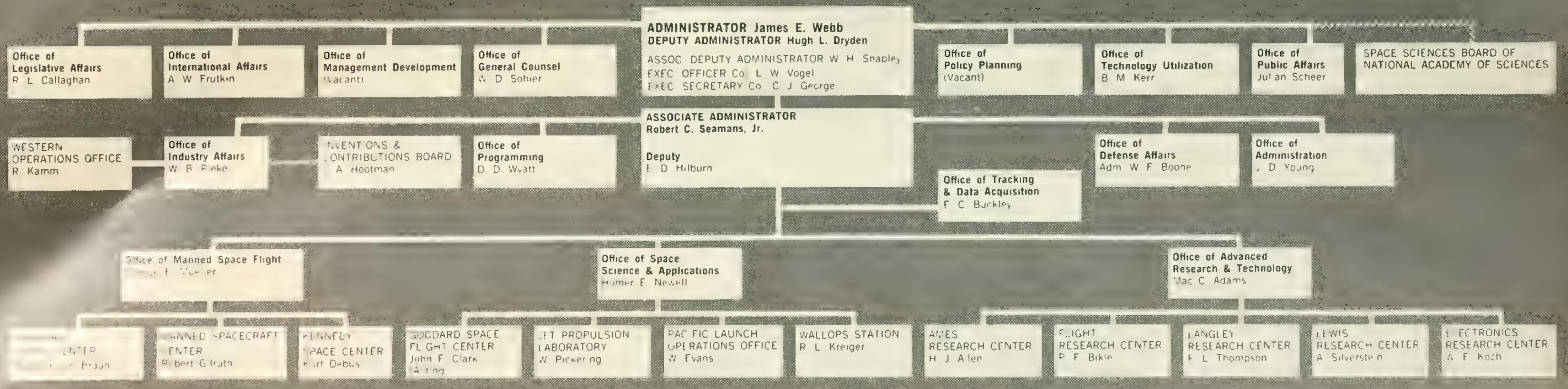
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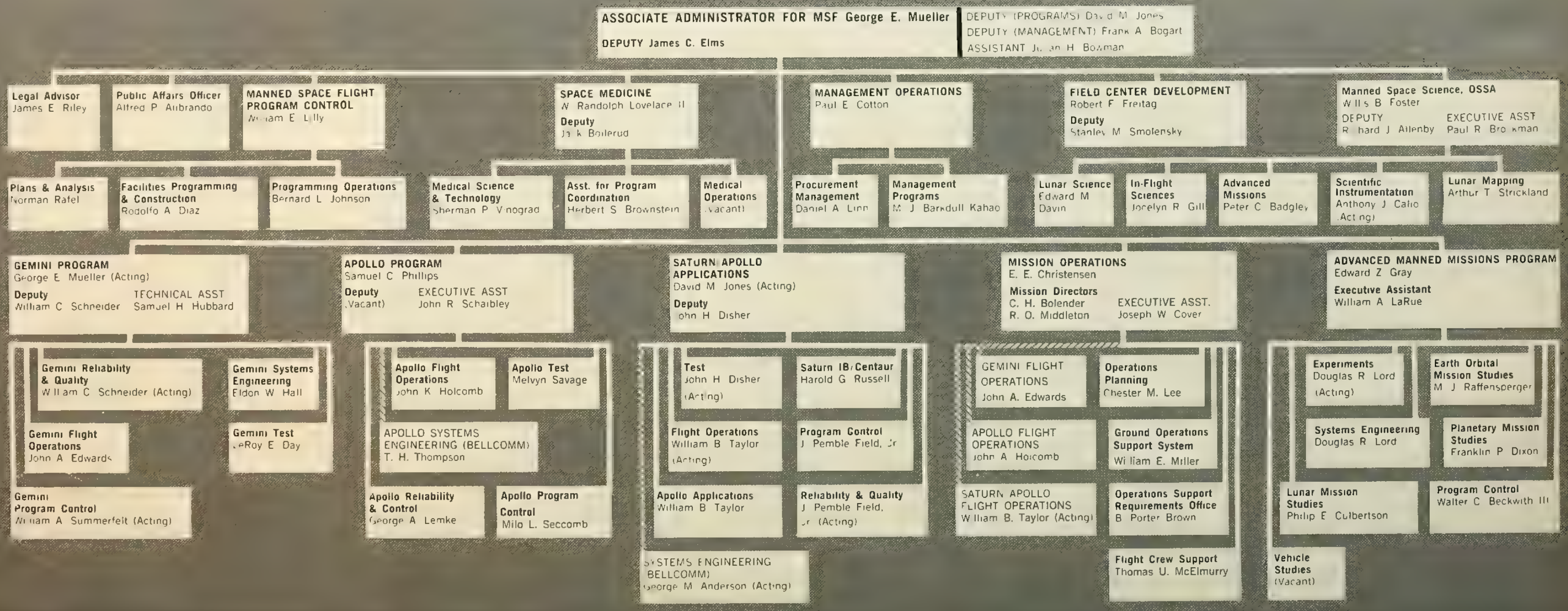
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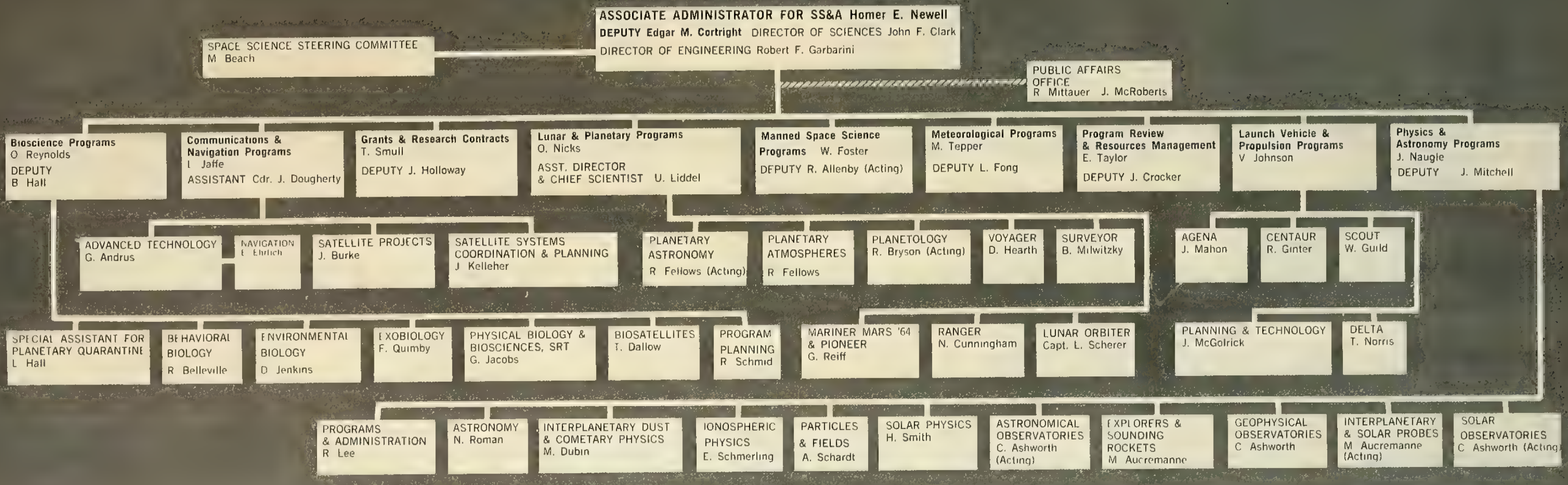

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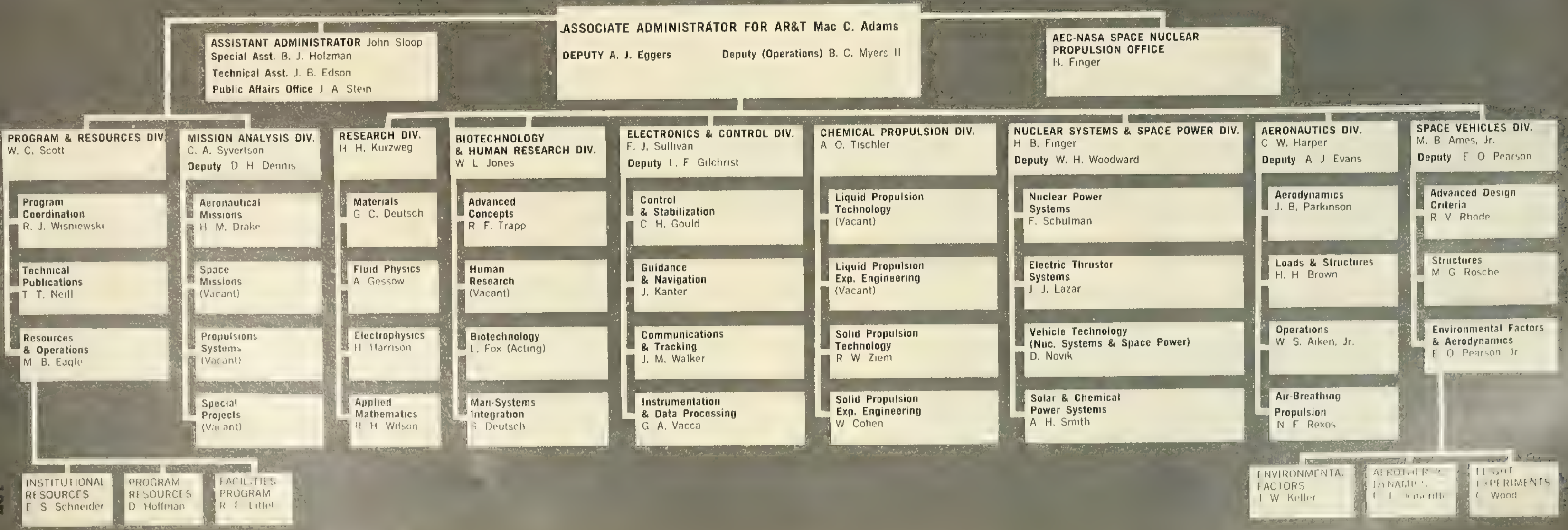

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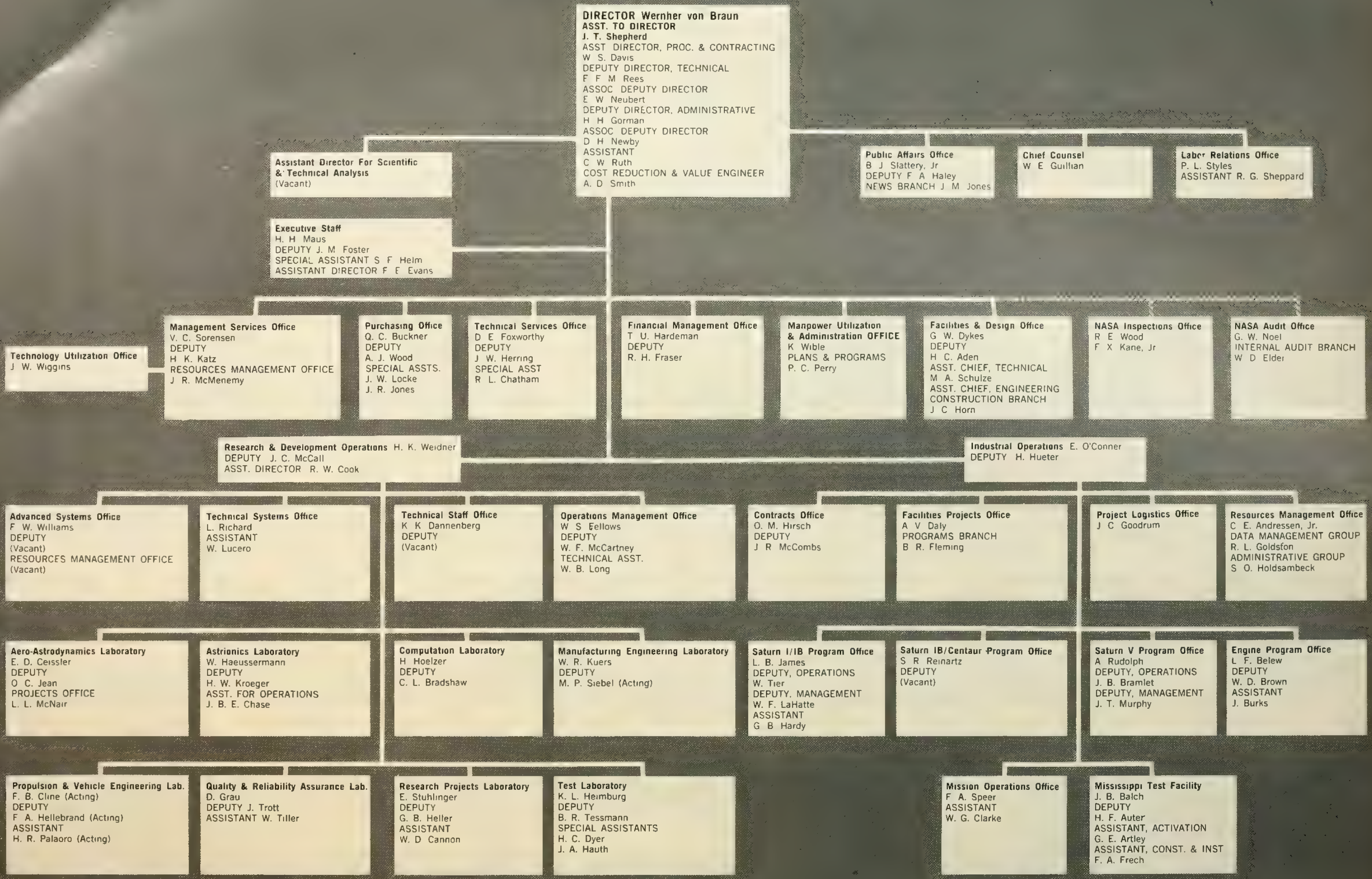

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NEW!

CEC announces the first low cost, three-in-one portable direct-writing recorder

CEC's new solid-state DG 5511 introduces engineering and performance advantages never before offered by any recorder in its price range.

This portable, 2-channel, thermal writing recorder is so versatile it provides the capability formerly achieved only through multiple instruments. The DG 5511 features *two* plug-in signal conditioners for a wide range of voltage inputs. *No* preamp is needed for high level signals. Due to its all-modular design, users may convert from high level signal inputs to low level inputs by a simple change of plug-in attenuator/amplifier units.

In addition, the DG 5511 is remarkably easy to use with its unique snap-in, front chart-loading and convenient push-button selectable chart speeds.

Frequency response is equally outstanding—d-c to 70 cps; flat to 125 cps at reduced amplitude. And its wide signal range (25 millivolts to 500 volts full scale) makes the DG 5511 readily adaptable to telemetry and computer readout. And of particular importance to industry is the fact that the DG 5511, being a true portable, may be used virtually anywhere there is a power source and wherever there are unknown forces such as vibration, pressure or temperature to be measured. Consequently, the DG 5511 is certain to be a "must" instrument for every conceivable application from foods and pharmaceuticals to chemicals, construction and heavy equipment.

Features:

- ▣ Portable
- ▣ Rugged and compact
- ▣ Lightweight
- ▣ Low cost
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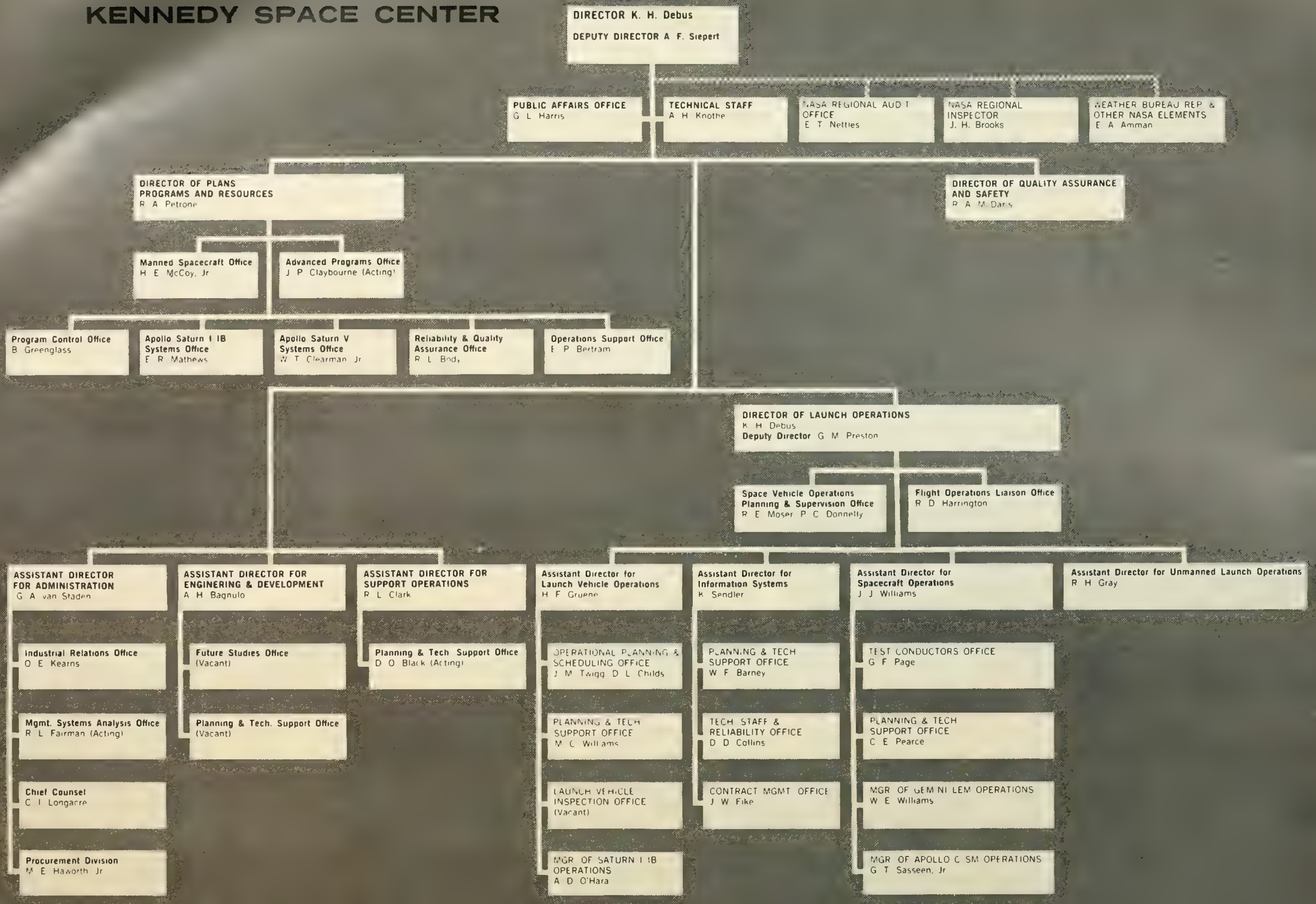
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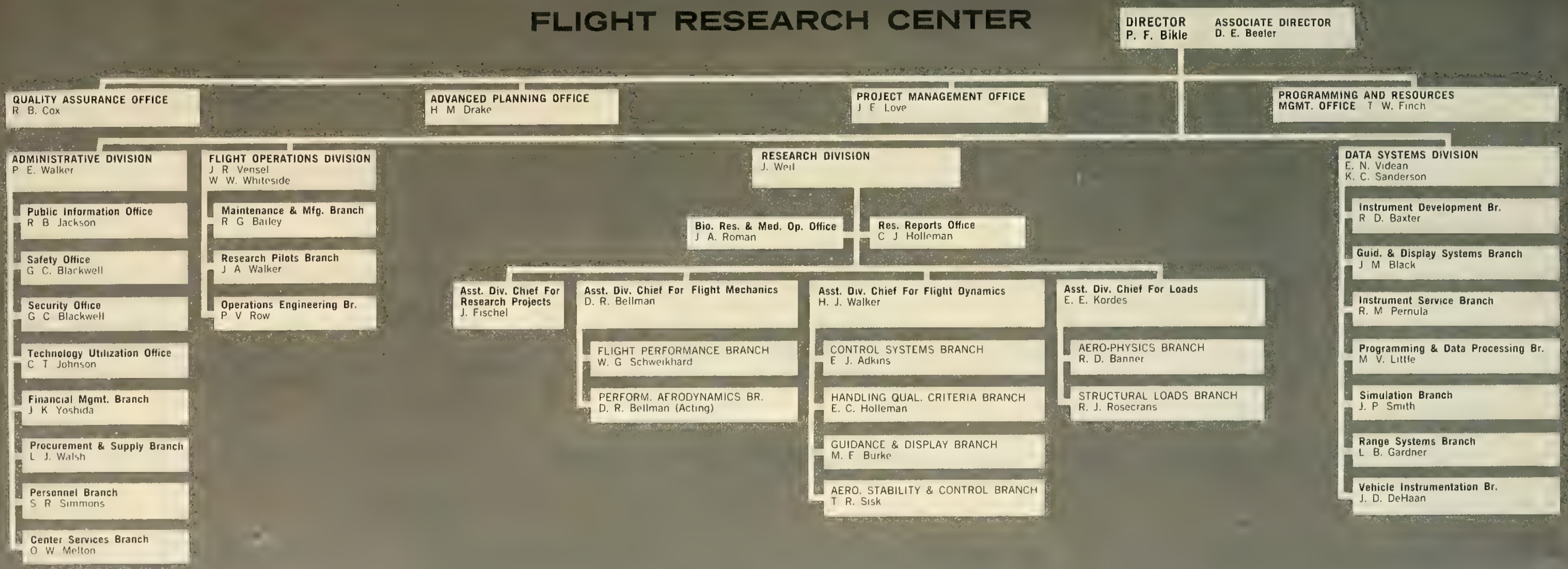

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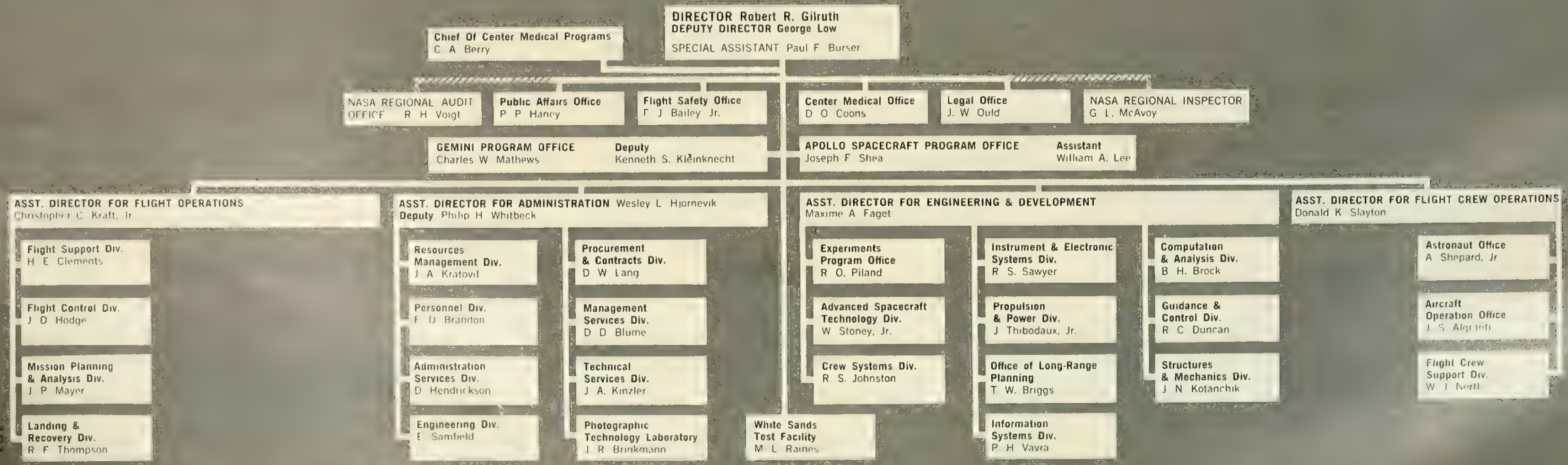

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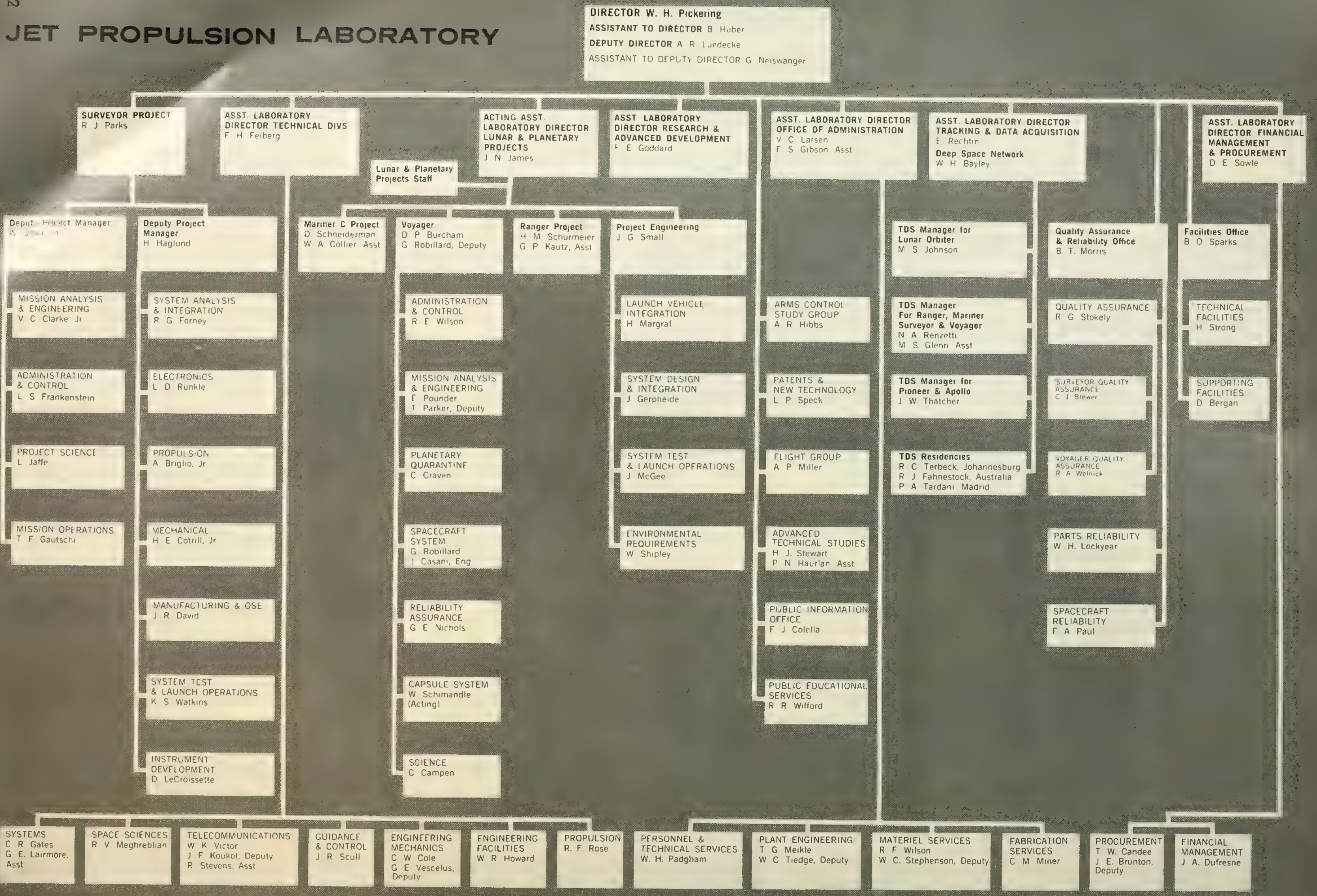

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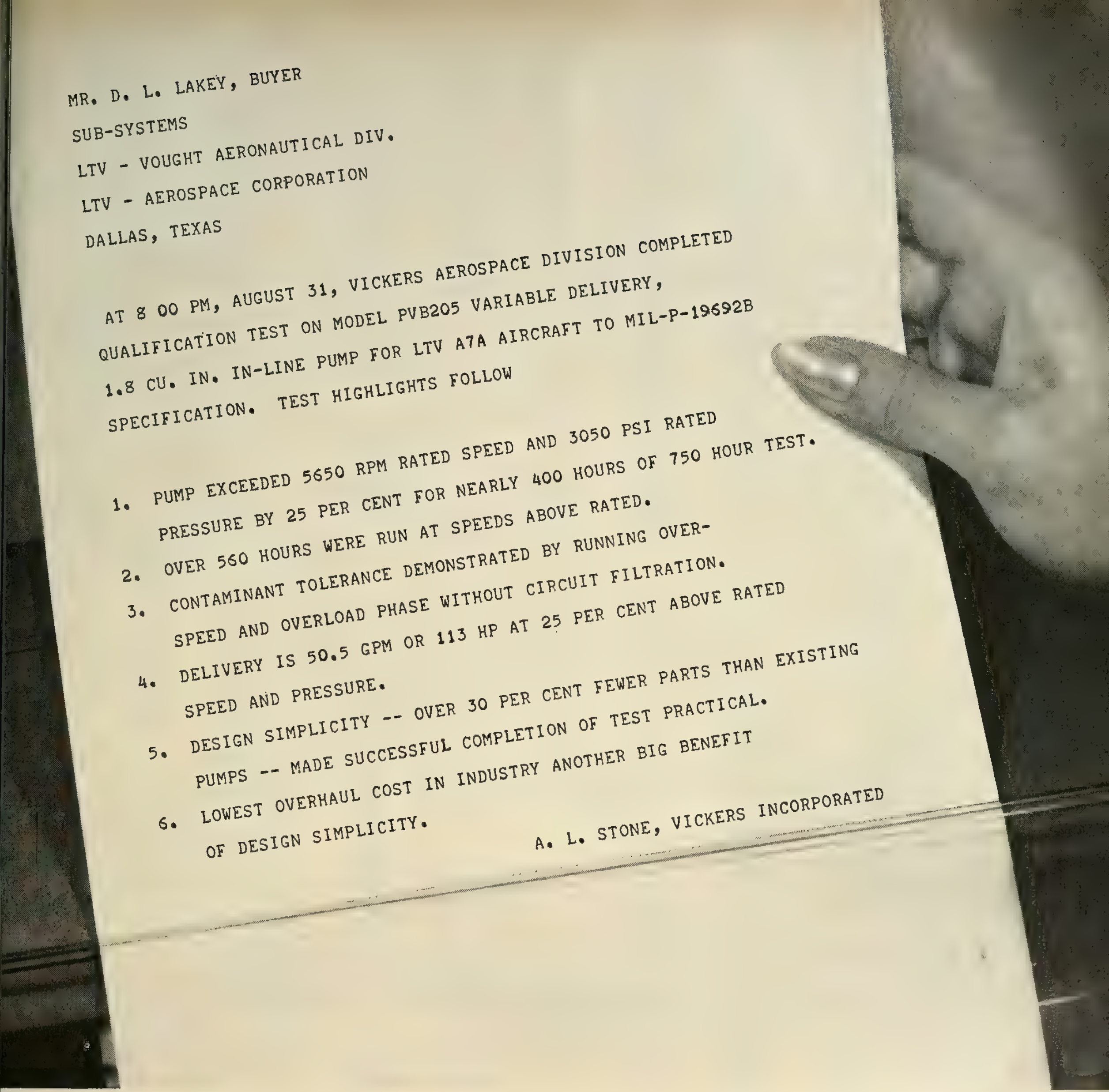

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1. PUMP EXCEEDED 5650 RPM RATED SPEED AND 3050 PSI RATED PRESSURE BY 25 PER CENT FOR NEARLY 400 HOURS OF 750 HOUR TEST.
2. OVER 560 HOURS WERE RUN AT SPEEDS ABOVE RATED.
3. CONTAMINANT TOLERANCE DEMONSTRATED BY RUNNING OVER-SPEED AND OVERLOAD PHASE WITHOUT CIRCUIT FILTRATION.
4. DELIVERY IS 50.5 GPM OR 113 HP AT 25 PER CENT ABOVE RATED SPEED AND PRESSURE.
5. DESIGN SIMPLICITY -- OVER 30 PER CENT FEWER PARTS THAN EXISTING PUMPS -- MADE SUCCESSFUL COMPLETION OF TEST PRACTICAL.
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More data is available. You can get it in New Bulletin A-5293, "In-Line Pumps for Aerospace Industry" from: Vickers Incorporated, P.O. Box 302, Troy, Michigan 48084.

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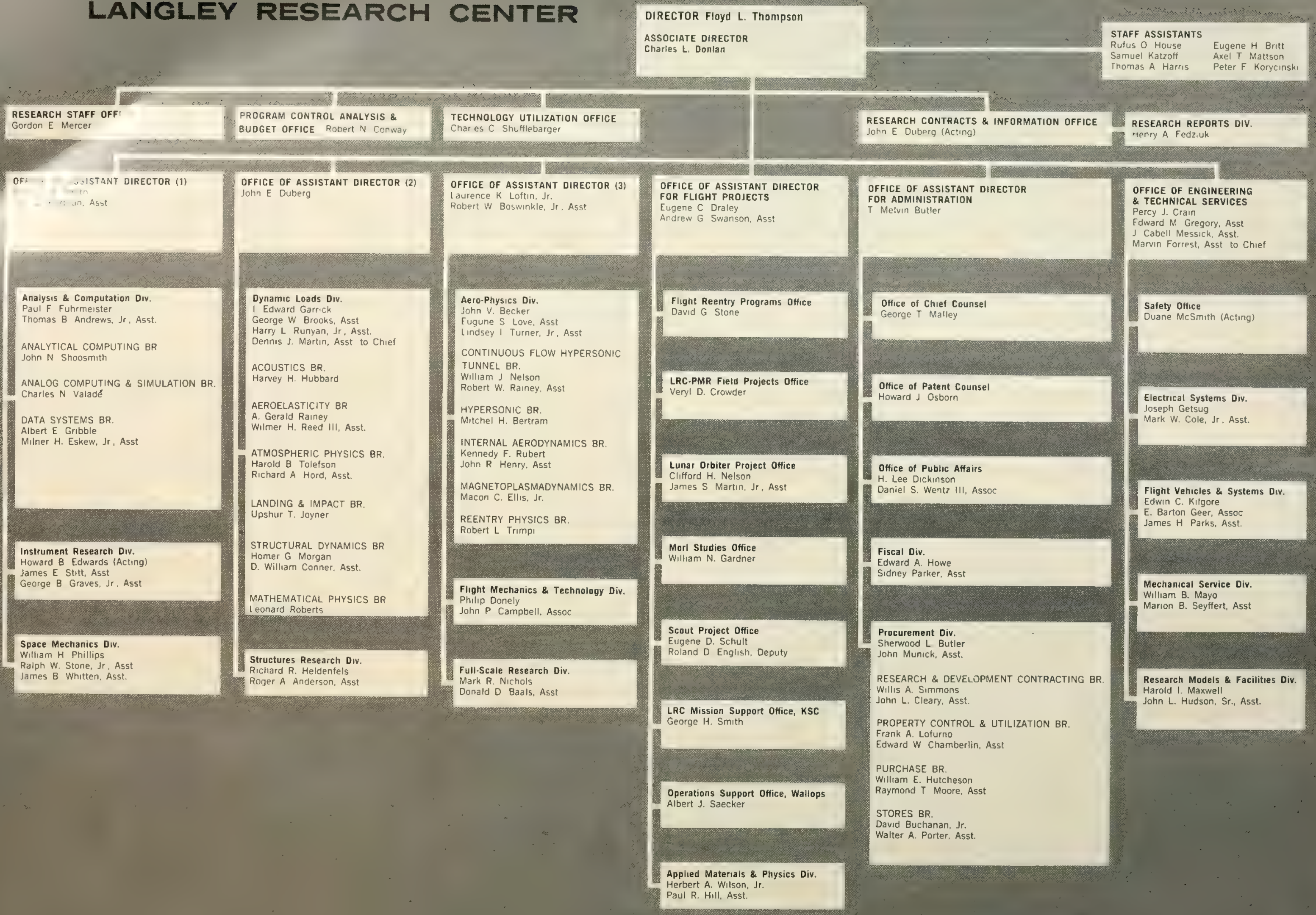

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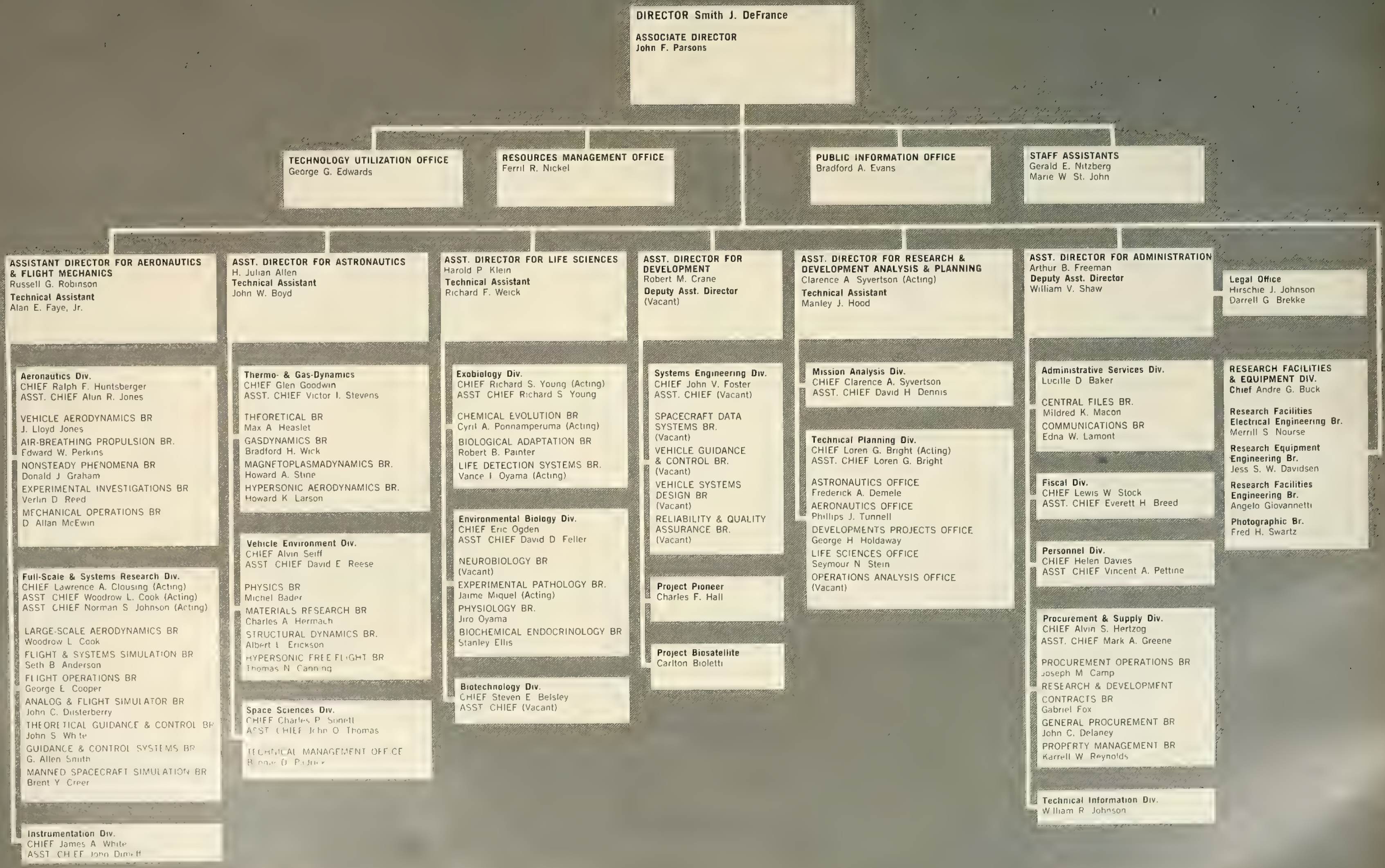

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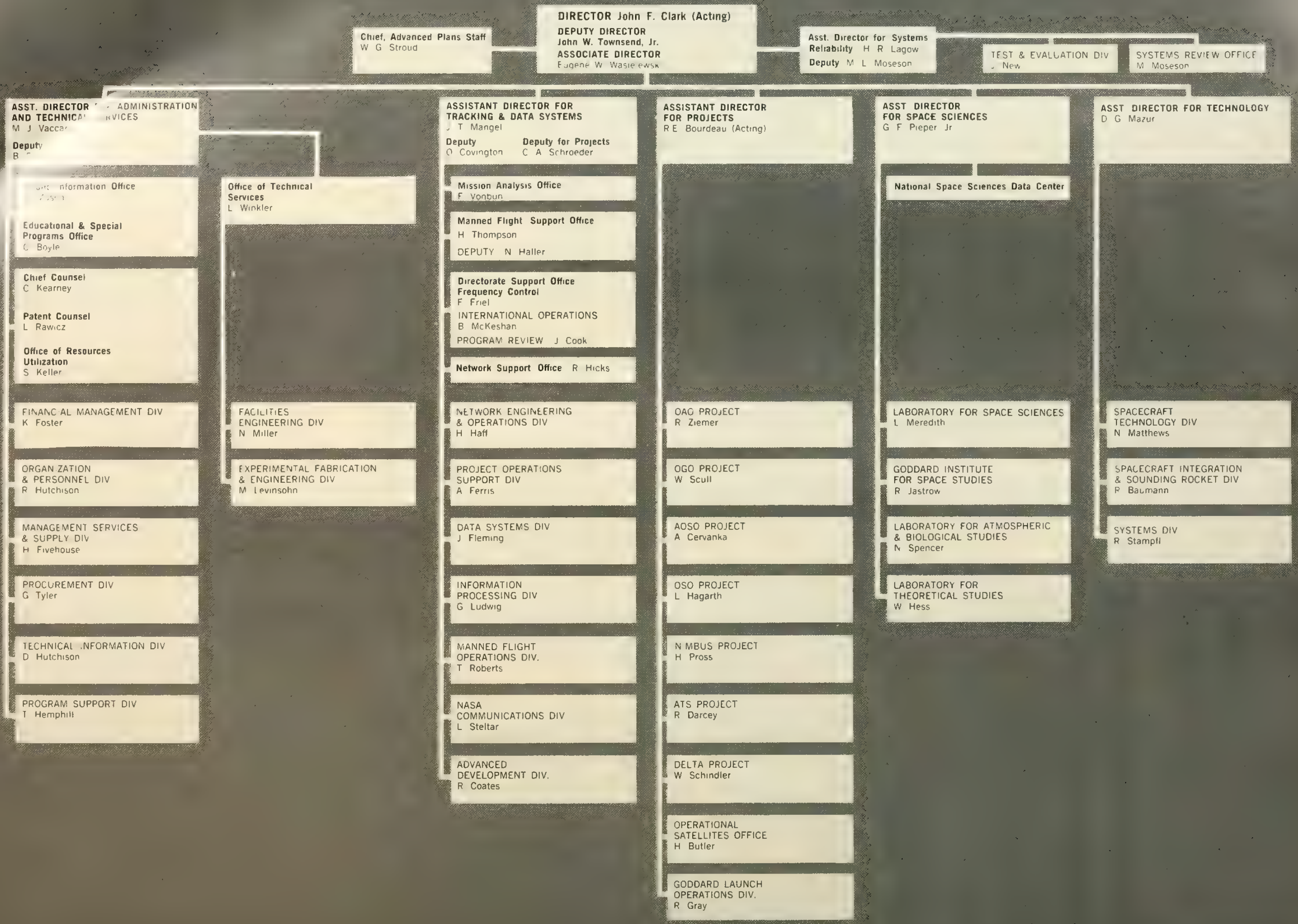

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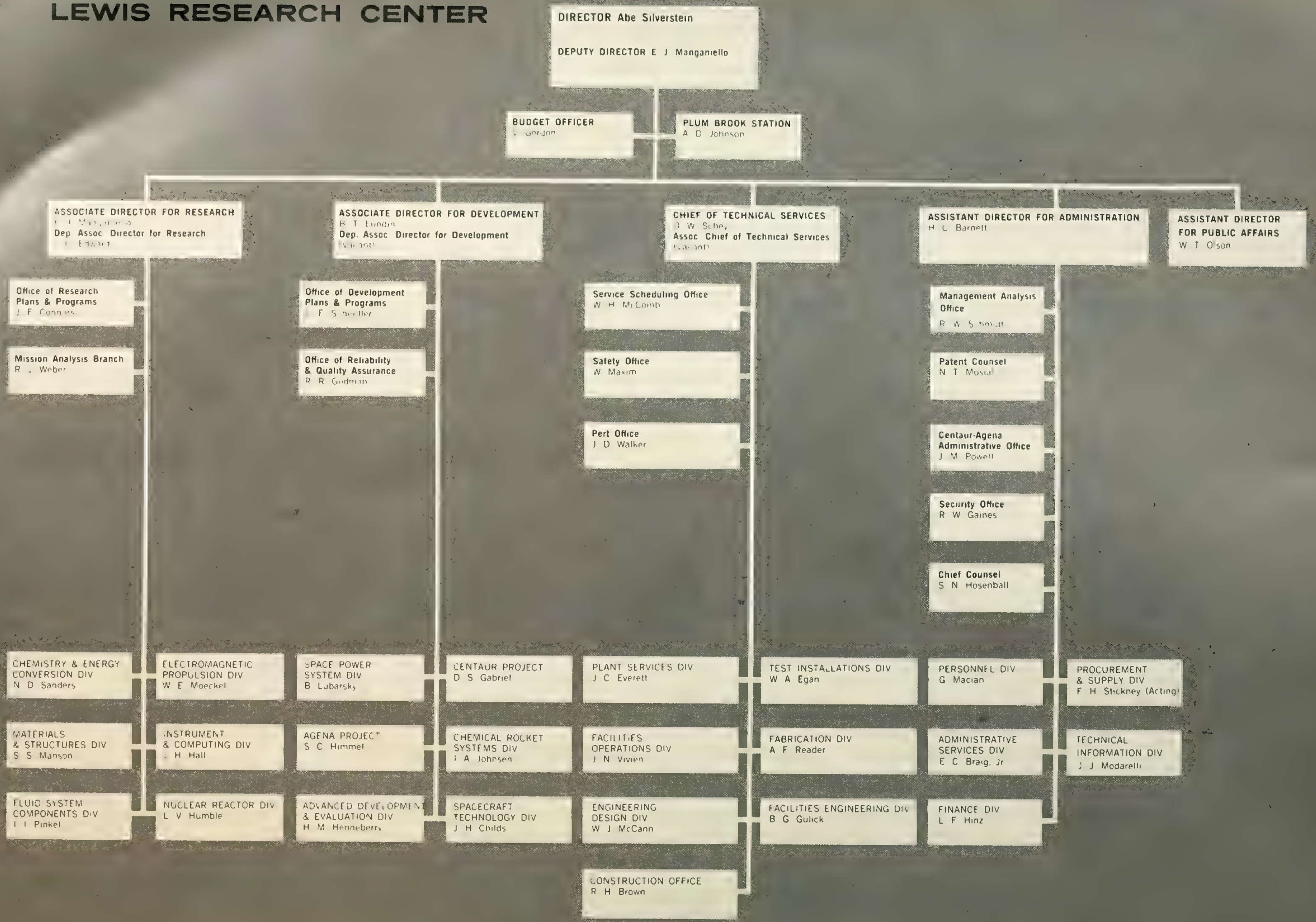

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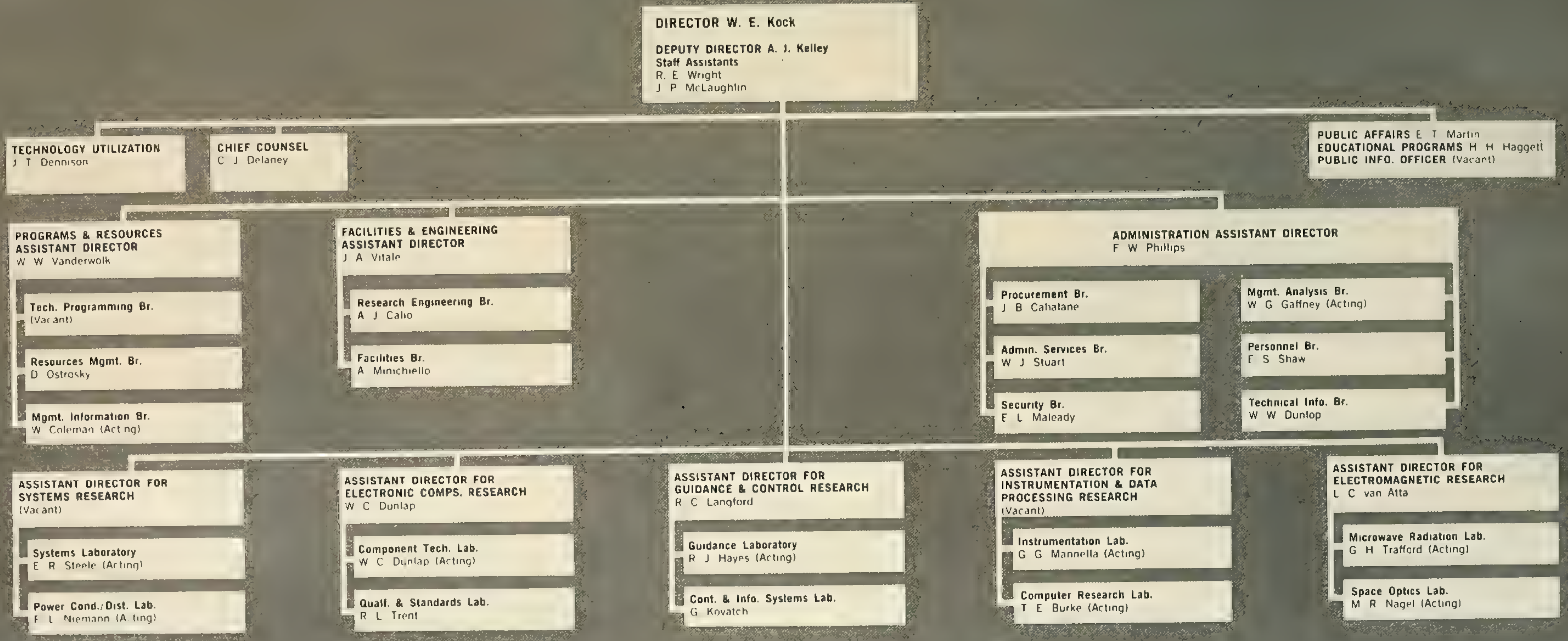

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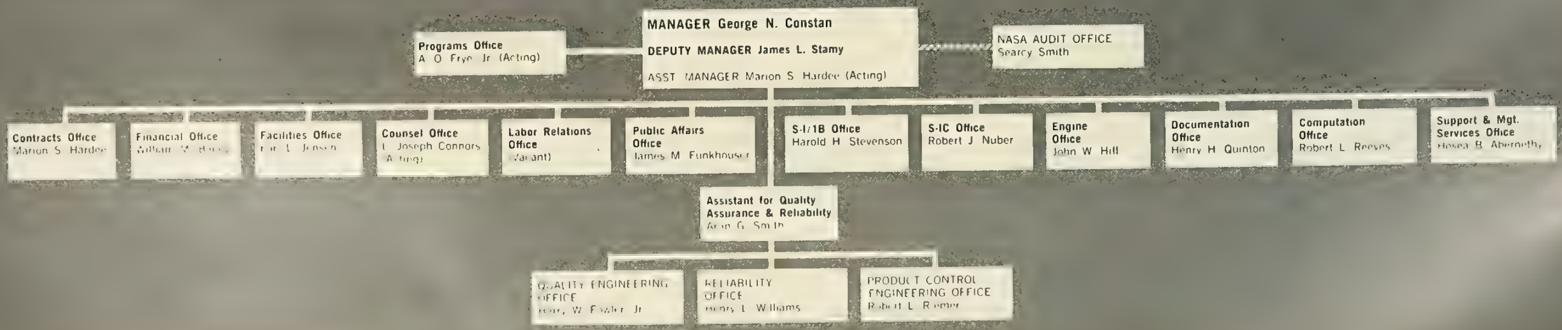

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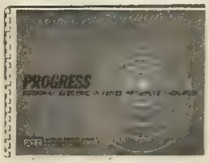

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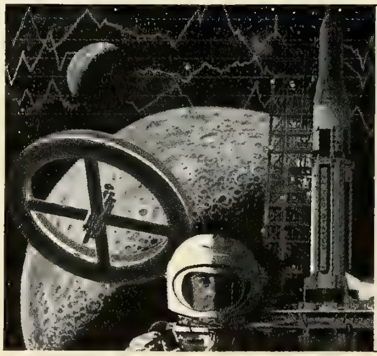

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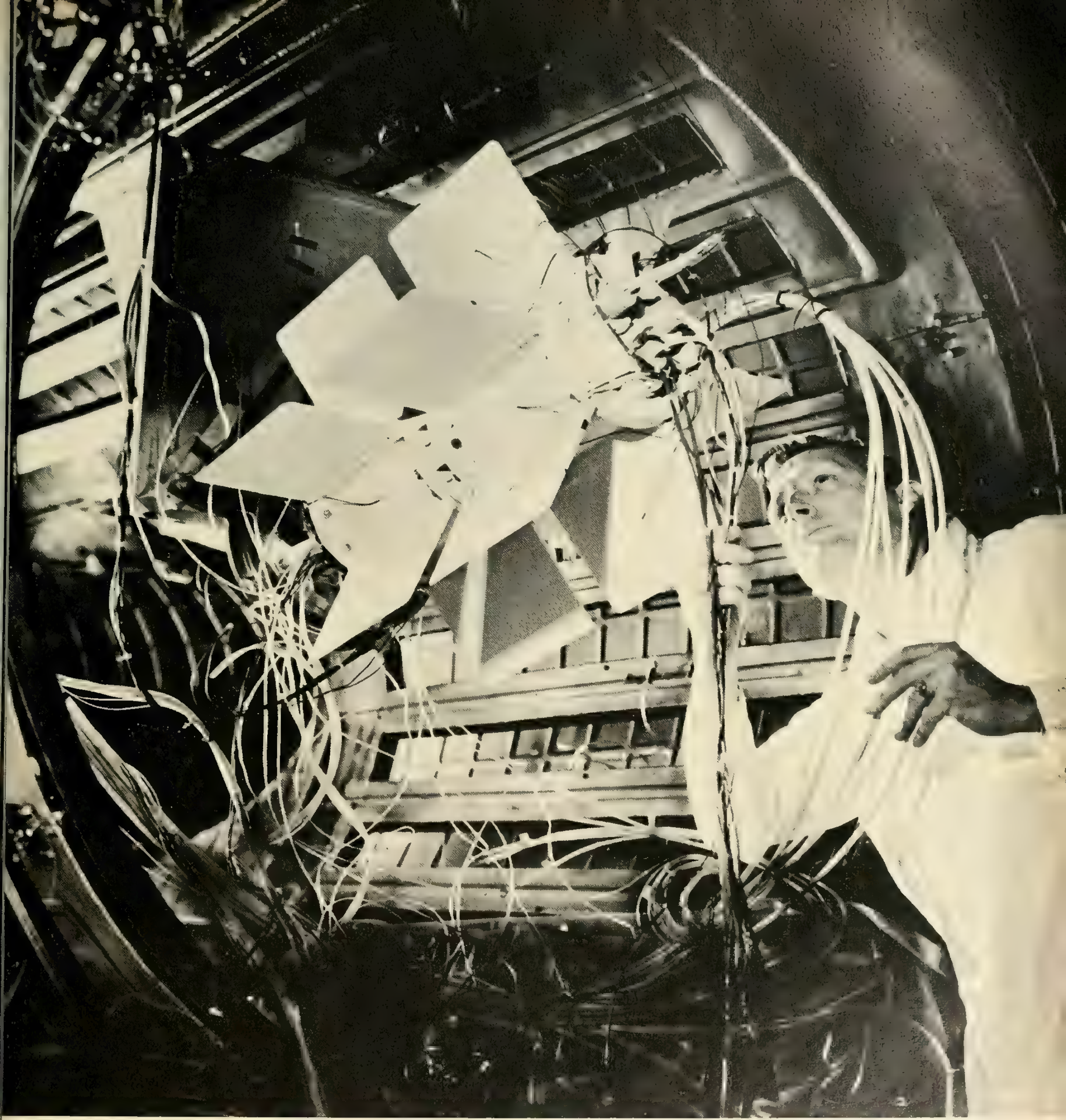


TECHNICIAN adjusts wiring on two nuclear generators that will power Nimbus B weather satellite.

PART IV

NUCLEAR SPACE POWER AND COMMUNICATIONS SATELLITES

Space System Control Tightened

Finger's responsibility grows with creation of new AEC post; lack of mission requirements hobbles power unit development

RESPONSIBILITY FOR all space nuclear systems—from electrical power generators through nuclear rockets—is now concentrated under one individual even though the programs extend through two separate agencies.

NASA's Harold B. Finger, also recently appointed director of a new Space Nuclear Systems Div. in the Atomic Energy Commission, now has total responsibility for everything nuclear in the space program.

With a budget currently running in the \$250-million area, space nuclear programs range from the highly successful in the rocket area, to a series of cancellations and a probable change in emphasis, in the power areas.

W. H. Woodward, deputy director of the Nuclear Systems and Space Power Div. in NASA's Office of Advanced Research and Technology, says the power picture is hampered by a lack of specific requirements. But, since the mission definitions themselves are not firm, there is little reason to expect any firmer definition of power needs.

Woodward, as others in the nuclear space programs, concentrates on technology and tries to keep an across-the-board ability in all forms of power systems concepts.

- **Germantown group**—In AEC headquarters at Germantown, Md., the Commission's space-related nuclear research and development activities have been combined in a Division of Space Nuclear Systems, with Finger as director. Finger reports to Dr. John A. Swartout, asst. general manager for reactors.

This division has two major parts—the joint AEC-NASA Space Nuclear Propulsion Office, also handled by Finger, and the newly established Space Electrical Power Office (SEPO).

SEPO is responsible for the Commission's space reactor and isotope electric power systems work, including the SNAP systems and space oriented reactor concepts work. Development of SNAP systems related to terrestrial and ocean applications remains under the direction of the Division of Reactor Development and Technology.

Isotopic fuels development work remains with the Division of Isotopic Development, and the responsibility for the production of all nuclear fuels lies with the Division of Production.

The SEPO sections cover isotopic power systems, reactors, advanced reactors such as the liquid metal, and gas-cooled versions and the boiling potassium reactor at Oak Ridge, Tenn. There is also a small effort in working thermionics into reactors—but this may increase during the next two years.

The major emphasis in SEPO is on reliability and safety. The safety aspect includes the various options in space operations and re-entry—total burn-up, intact re-entry (random or controlled), and dispersion.

The total program effort at SEPO has three major characteristics—studies first define the development effort needed to result in the technology, programs are initiated to develop the technology, and the technology is used to design specific systems.

The AEC portions of the space-oriented nuclear work are often continued to more definitive conclusions after an entire program has been cancelled. This is true in the SNAP-8 instance where the reactor portion of the program will continue.

This is because the heat sources—isotope or reactor—are better classified as families and the technology often serves in several different end applications. While the offices are separate on the organization charts, the entire NASA-AEC space nuclear effort is close-knit. DOD/military coordination is described by Finger as excellent.

SPACE POWER

The emphasis in solar cells, currently the predominant source of electric power in space, is on large, foldable arrays. At the moment, the silicon cell is the only material that makes sense, but other materials are being researched.

The problem of building large solar cell arrays is now being defined. The tentative objective is to build four foldable arrays, each with an area of 1,250 sq. ft. to check out packaging and deployment on a single vehicle. This would result in an array area of 5,000 sq. ft.

There are four current studies on arrays—at Ryan Co., Boeing, Electro-Optical and Fairchild Hiller. The investigations cover both fold-up and roll-out deployment concepts. The size of such arrays forces consideration of extremely lightweight designs.

The silicon solar cell itself has received attention in the radiation-resisting and thermal-resisting areas. The large arrays would use 8-mil-or-less-thick cells. The power generation area of interest is 50 kw, with lower weight a prime element. The present state of the art is 10w/lb./ft.^{2}, operational in the 1-au regime. This is the *Mariner IV* array technology.

Arvin Smith, chief of the Chemical and Solar Electric Power section in NASA's Nuclear Systems and Space Power Div., says the major emphasis until last year was on radiation damage. In this respect, work is progressing on drift-field solar cells and thin-film materials. Smith would still like to see silicon cells more radiation-resistant and some \$1 million is now funded for this research.

- **Thin-film picture dark**—In thin-film solar cells, Smith exhibits some pessimism. The cells are unstable and not efficient at this stage of the research.

Besides solar cells, Smith says NASA is actively investigating the use of solar energy in both the thermionic and turboelectric conversion areas. The turboelectric work is concentrated on the single-phase, inert gas Brayton cycle and a hot test of key components is slated for the near future at the Lewis Research Center.

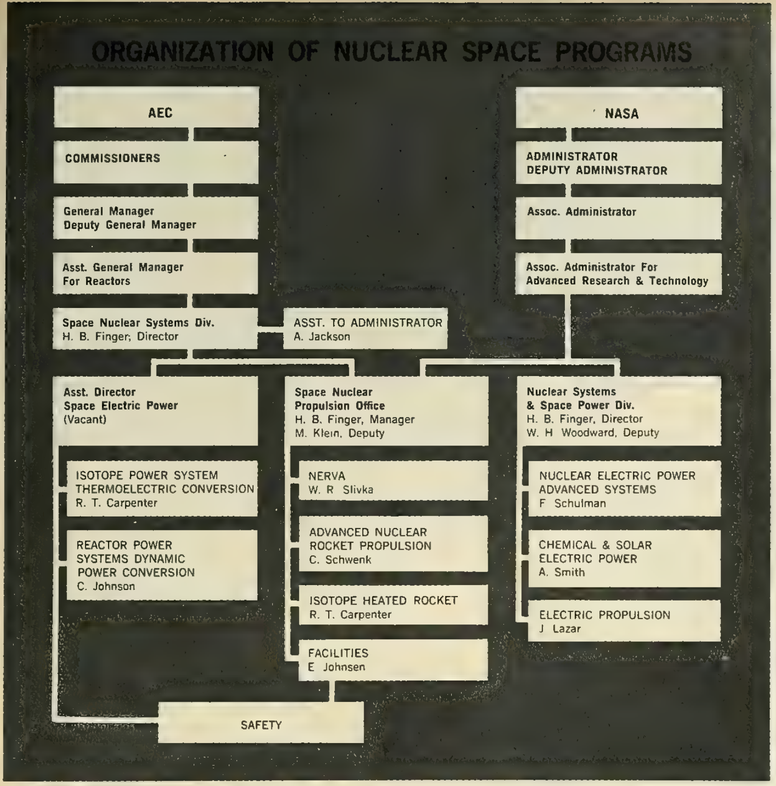
Smith is less than enthusiastic about the dynamic solar energy systems, but the work is supported because there might be a 20% overall efficiency increase and less concentrator area. This latter advantage is somewhat offset by the need for a radiator. The reference unit here is 10kw.

Jet Propulsion Lab scientists are examining the thermionic applications involving solar energy and there is an effort at Lewis. But the emission level is around 2,900°F, somewhat high for solar energy.

The whole solar energy application area is governed by distance from the Sun—being too close or too far away reduces the efficiency and poses problems of different types.

CHEMICAL POWER

The chemical electric generators are ordinarily fuel cells and batteries. Fuel cells are already partly efficient, says Smith, and only small improvements



can be expected in this category.

But, in addition to performance improvements, long life is being emphasized. Smith says of the three main fuel cells now in being—at General Electric, Pratt & Whitney and Allis-Chalmers, the Allis-Chalmers seems to have the best potential for long life. OART is not funding these units since other NASA elements, especially the Office of Manned Space Flight, are carrying the work.

Smith's reasoning is that the P & W system, being a high-temperature process, implies materials problems and the GE cell will probably have a membrane problem with respect to long life. NASA experts cannot pinpoint any such weaknesses with the A-C unit, but lack statistical data.

One major area receiving attention in prolonging fuel cell life is the recycling of the compounds—but Smith indicates a time problem here. Several fuel cell applications now under consideration involve lunar surface work and the early nuclear power plants may reach fruition in time for use.

In batteries, the target area is 20 watt-hrs./lb. and the primary contenders are the silver-zinc, silver-cadmium and such ingenious concepts as the Monsanto dry tape battery.

There is also a difficult problem in using batteries for those payloads demanding sterilization. There is experimental work in batteries, testing impact resistance and operation under extreme environment conditions.

NUCLEAR GENERATORS

The nuclear power systems in the NASA Nuclear Sysems and Space Power divisions are under Dr. F. Schulman. In the isotope power generation area there are several programs in various stages of development.

- **SNAP-11**—An electrically heated generator prototype of the SNAP-11, a 25-watt, 90-day, 33-lb. CM-242 unit designed for use in *Surveyor*, has been delivered to the Jet Propulsion Laboratory. The unit will not be used because of *Surveyor* mission changes, but the AEC is planning to bring this program to logical conclusion with a fueled demonstration at Oak Ridge in 1966.

- **SNAP-19**—An improved version of the successful SNAP-9A, SNAP-19, is being developed in support of the Goddard Space Flight Center *Nimbus* weather satellite program. First scheduled use is on *Nimbus-B* in 1967.

The unit is a plutonium-238-fueled, 30-watt generator with a lifetime of 5 years. An electrically heated prototype has been delivered to GSFC and the first fueled prototype will be delivered in July, 1966.

- **SNAP-27**—A power unit package to be left on the lunar surface by the *Apollo* astronauts in conjunction with the *Apollo* lunar surface experiment package. The generator will be fueled with Pu-238 to supply 50 watts over a 5-year lifetime and weighing 25 lbs. The second phase of this program began this fall.

- **SNAP-10A**—The only reactor program still maintaining some semblance of development is the SNAP-10A program. Already flight-tested in NASA's first launch with a nuclear power source, the system is under study to increase the temperature capability of the thermo-electric elements and increase the fuel temperature capability of the zirconium-hydride fuel system.

The 10A unit provides 500 watts for one year with weight of 1,000 lbs. SNAP-10A was launched from Vandenberg AFB, Calif., on April 3. The *Atlas-Agena* vehicle achieved a nearly perfect 700-n.-mi. orbit.

SNAP-10A was designed to operate at full power with the unusable portion being absorbed in a resistor bank. Sometime between the 552nd and 555nd orbits, the reflector halves on the unit had been ejected and the power output went to zero.

The most probable cause of shutdown was a sequence of failures of spacecraft electrical components with the resultant spurious commands shutting down the reactor.

Neverthless, SNAP-10A met all performance objectives except that of the full-duration flight.

- **SNAP-8 and -50**—Schulman is presiding over the phasing out of the SNAP-8 program. SNAP-50 has also been cancelled as a program, but some research on the reactor continues at the AEC Livermore, Calif., facility.

All SNAP-8 work at NASA has been re-oriented toward single line objectives. The idea is to get the most possible information out of the work in hand without the usual design support effort. Despite this and a reduction in personnel, Schulman says the heart of the SNAP-8 system—the turbo-alternator—reached some 830 hours of running time by last June before a turbine failure stopped the run.

Schulman is also encouraged by the sodium-potassium pump. This component of the dynamic conversion system for SNAP-8 has run at temperature over 2,000 hours. The leak rate around the seals was less than 1 lb. per year.

SNAP-8 did not have a specific mission objective when originally planned. The system was designed to generate 25 kw over 10,000 hours' lifetime at a total system weight exceeding 6,000 lbs.

Even though cancelled, the program has indicated problem areas for high-power dynamic conversion-nuclear reactor electric systems. Schulman says it is now clear that the heat transfer in mercury boilers is more complicated than originally anticipated. The boiler behaves erratically and is still a major development problem.

Schulman says that if and when problems crop up in a program during the phasing out operation, there are no people or equipments to concentrate on it. Testing is also slower.

Schulman's group is also trying to improve the SNAP-8 without any design changes, in an attempt to get more realistic weights. For example, the original design is conservative and the elimination of the mercury vapor bypass in the system could reduce the weight by 3%.

- **Conversion systems weighed**—With respect to the various conversion systems, Schulman feels the Rankine cycle offers the best hope for a lightweight system, but the liquid metal technology is both costly and difficult to demonstrate. Since the temperatures are high with such dynamic systems, refractory metals must be used and the type missions envisioned involve operating unattended for a year at least, and probably for several years.

Schulman says the Brayton cycle does not offer any great advantages when coupled to reactors, and the area of application for this cycle is more likely to be in the isotope power field. In addition, the Brayton cycle will not be a prime power for electrical propulsion.

Thermionic conversion, being a static system, has the advantage of avoiding the rotating machinery so necessary to both the Rankine and Brayton cycles. Another prime advantage says Schulman, is that the diode units offer an easy route to redundancy.

- **Thermionics a long way off**—Schulman says thermionics is still best classified as being in research and a long way from demonstration as a complete electrical producing system. It is obvious that the power people throughout NASA believe the dynamic conversion technology should be supported. Schulman says that these systems are working at a lead time of about 15 years, so applications will not be nailed down until after 1980.

The leadtime for electrical generation schemes are longer than mission leadtimes, so the technology must be supported without recourse to specific missions. Schulman claims the major exception to the 1980 rule is SNAP-8. This system could be operational by 1975.

In addition, the SNAP-8 work had a larger value—the approaches to problems posed by such systems without too much regard to size would be defined in developing SNAP-8. Schulman says there are many unknowns in the progress of dynamic systems from conception to operation and there is no way to clarify these without actually working with the hardware.

The second major dynamic power reactor system to disappear is the SNAP-50 program. SNAP-50 was designed to be a fast reactor in combination with a dynamic conversion system through lithium-potassium fluid loops.

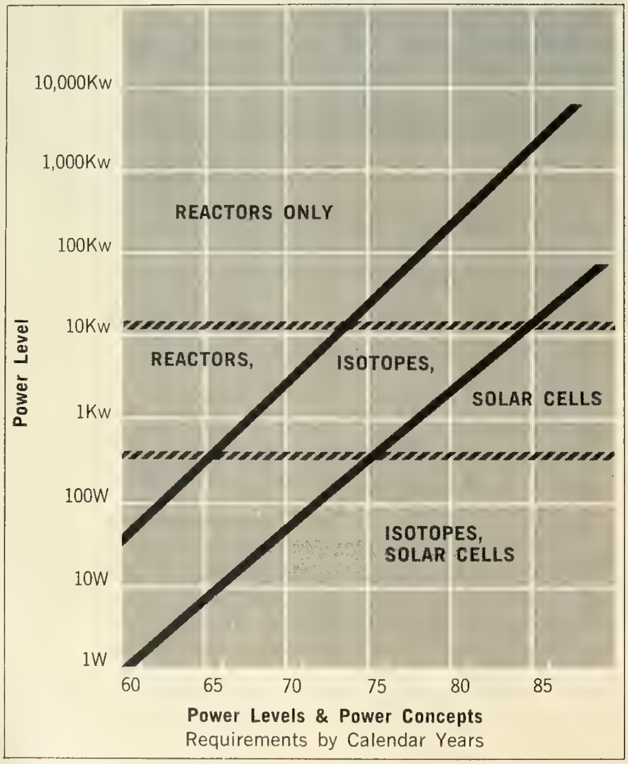
SNAP-50 was a demonstration model for electrical propulsion and auxiliary power systems. It would generate power in the 300,000 w to 1-megawatt area for 10,000 hours.

The SNAP-50 cancellation was accompanied by indicated Congressional pressure for less expenditures in the advanced power area until conversion systems other than the rotating machinery principles used in the Rankine and Brayton cycles. The specific technology mentioned by Rep. Craig Hosmer (R-Calif.) of the Joint Committee on Atomic Energy is thermionics (M/R, Oct. 18, p. 24).

This may result in some significant changes throughout the power system technology research structure. For one thing, the dynamic systems may be downgraded or possibly dropped—if some of the thermionic developments hinted at by Hosmer, industry and AEC sources are as good as they seem.

- **Megawatt question**—And then it may be a question of power levels. Dr. John C. Evvard of the Lewis Research Center has concluded that the development of a thermionic system in the megawatt area needed for significant use of electrical propulsion is probably more difficult than the high-temperature, liquid-metal Rankine cycle system.

In his analysis, Evvard refers to the plasma thermionic converter—which is a thermionic converter with an easily ionized gas such as cesium inserted to



THERE IS NO one power source for all missions. This graph prepared by Dr. Joseph D. Lafleur and Robert T. Carpenter of the AEC Space Nuclear Systems Div. is based on a comprehensive DOD-NASA-AEC study of mission projections. The diagonal bands represent the general progression of power requirements during the next 20 years. Major uses for solar power and isotopes exist now, but it is apparent that after 1975, missions appear that can be accomplished only with reactor systems.

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The sixth straight shot for the Douglas S-IV upper stage of the Saturn I rocket marks an unprecedented 100% success for a major space program. And now the National Aeronautics and Space Administration's Saturn I-B rocket, with a Douglas S-IVB upper stage, is soon to begin flight testing.

At Douglas' huge research and industrial facility in Huntington Beach, California, the most advanced in the world, Saturn S-IVB stages are being built under the direction of NASA's Marshall Space Flight Center. One of these, as the third stage of the Saturn V rocket, will put Apollo in earth orbit and then moon orbit before 1970.

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neutralize the electronic charge established in a vacuum.

The theoretical Carnot efficiency of the plasma thermionic converter ranges from 25 to 50%—but experimental efficiences have reached only the 17% level as a maximum. In addition, says Evvard, the remaining heat energy must be discharged to space by a radiator, and since the highest efficiency occurs with the lowest anode temperature, this suggests a larger radiator.

When the weight of the system including the radiator is minimized, the efficiency is about 10%, or slightly higher with the new meteoroid data.

Evvard also indicates that the use of the converter in a space power system forces a choice between installing the elements in-pile or out-of-pile. The out-of-pile arrangement is much easier and straightforward and would use a liquid metal or gas loop to carry reactor heat to the diodes. (Tests in both instances now total in the thousands of hours, but in the low watt regime.)

Evvard says the limiting temperature of the liquid metal system occurs in the reactor with the cathode at a still lower temperature. In this system, there is about a 600° F penalty on the maximum cathode temperature leading to estimated system weights so large that out-of-pile thermionic conversions systems are not interesting for electrical propulsion at this time .

● **Thermionic shares radiation problem**—About 90% of the energy generated in the reactor must be carried to the space radiator by means of a working fluid. Because the converter is a high-temperature device, the anode cooling and the transfer of heat to the radiator are accomplished by a liquid-metal system.

This means, says Evvard, that the thermionic system has the same limitations on performance, due to the use of liquid metals, as the Rankine system. The thermionic converter may operate at higher temperatures (turbine inlet temperature corresponds to anode temperature), but gains from this difference are offset by the lower efficiencies of the minimum-weight diode system.

Evvard says studies into the use of gaseous cooling of the anode to raise the operating temperature have shown that the pumping power required to circulate the cooling fluid was unreasonably large except when large temperature drops across the radiator were employed.

Then the radiator becomes both large and, with meteoroid protection, heavy.

Evvard says no one has yet designed a satisfactory liquid-cooled thermionic power system for space. "One might propose a reactor composed of a critical assembly of thermionic diodes, each with its uranium-fueled cathode. The engineering problems associated with balancing the nuclear characteristics of such a reactor with the diode thermal and electrical requirements, including the multiplicity of series and parallel groups of diodes, each cooled with a properly insulated liquid-metal system connected to a common radiator, is challenging, to say the least."

Add to this the requirement for the replaceability of each radioactive diode unit upon failure and the problem becomes even more difficult.

There is still another major problem—thermionic systems require a relatively heavy power conditioning system to provide the proper voltage and currents for electrical propulsion. "When engineers are actually faced with the job of designing a complete thermionic system, they may find that the optimistically low estimates of the weights of the thermionic conversion systems sometimes included in the literature will grow to equal or surpass the weight estimates of the more conventional approaches," says Evvard.

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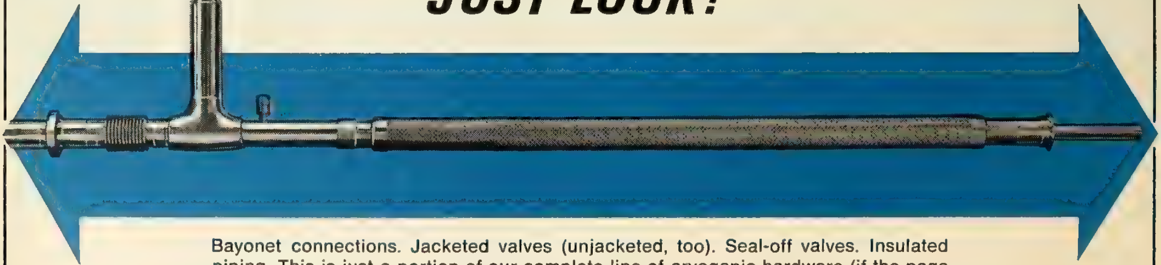

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propulsion is still something of a dream because of the megawatt power levels needed over long-term flights, the micro-thrust concepts are very close to operational use in satellite station-keeping and attitude control.

J. Lazar, chief of electrical propulsion in the Nuclear Systems and Space Power Div. says a 10^{-5}-lb.-thrust ion engine and a 10^{-4}-lb.-thrust resistojet system will be delivered to the Goddard Space Flight Center by the Lewis Research Center as back-up auxiliary propulsion on the *Application Technology Satellite* series.

The present auxiliary propulsion system is a subliming solid rocket, but there are problems with the units and there is some doubt the solid will attain low enough thrust levels.

In any event, Goddard has agreed to test-fly the ion unit on the synchronous altitude spin-stabilized experimental *ATS* in 1967. The electrical propulsion systems are backups for the synchronous altitude gravity gradient experimental *ATS*. The ion engine would be used for east-west station-keeping. The resistojet is the backup for the inversion function—reversing the spacecraft.

• Considered for SERT flights—The promised flight test and the very real possibility of replacing the subliming solid thrustors has resulted in shelving of the *SERT-3* flight. The technology and data involved in the *ATS* systems is the same as that which would be provided by the *SERT-3* experiment.

The electric thrustor back-up is a prime example of the transition from OART into application. Even though the *SERT-3* experimental flight has been postponed, Lewis researchers are developing a proposal for *SERT-2*—a 10,000-hour flight to wring out electrical engine concepts using current power sources. If this type of program proves possible, electrical propulsion is at the edge of some applications.

Lazar says electrical propulsion is being studied using *Voyager* and *MORL* as comparison mission models. This does not mean the propulsion is being considered for either of these programs. Initial studies indicate significant payload advantages can be had by using chemical boosters and then employing electrical propulsion for mid-course power.

• High-power propulsion from solar cells?—JPL is studying electrical thrustors using power supplied by solar cell arrays—and there are indications that NASA is considering megawatt solar cell arrays.

Lazar says there are other early applications for the various types of electrical thrust. For instance, the Langley Research Center is studying electrical schemes for the drag-cancellation of large satellites. The study covers 3-kw resistojets, and if the results look good, an experiment may be proposed for the *Apollo* Applications program.

Another early application is as mid-course propulsive power on planetary probes using solar power. As an example, a 25 to 30-kw engine system powered by a solar array used with a *Saturn IB* for a 300-day mission could increase the scientific package weight around Mars by a factor of four.

Lazar says power conditioning is the weakest area, but since previous examinations did not point to any major development problems, the technology can be easily brought up to par.

ROVER

The nuclear rocket propulsion efforts being pursued at NASA and AEC are guided by the Space Nuclear Propulsion Office (SNPO). Finger manages SNPO and essentially reports to himself on the AEC side since he is also the director of the Space Nuclear Systems Division at AEC. The deputy SNPO manager is Milt Klein.

In program categories, Klein's office handles NERVA, Advanced Nuclear Propulsion, including the Phoebus concept, the isotope-heated rockets and certain facility and safety responsibilities.

The major portion of the nuclear

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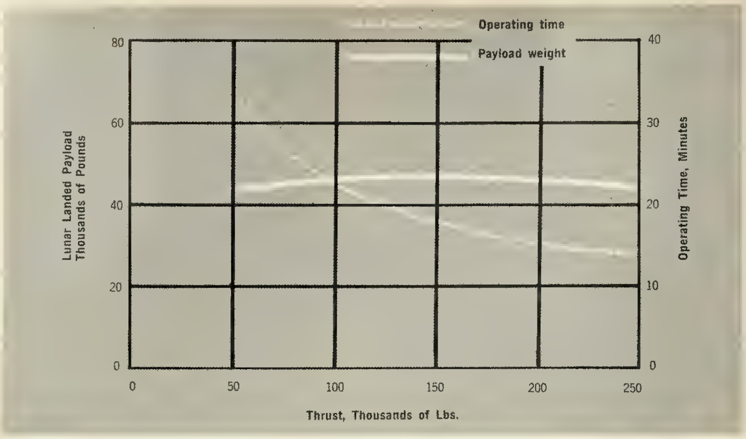


CONSIDERATION OF lunar operations and other missions using the Saturn V indicates that performance is largely unaffected by thrust variations in the nuclear stage from 50,000 to 250,000 lbs. Mars mission studies also show that requirements are relatively unaffected at thrusts above 150,000 lbs. Thus the nuclear technology as now formed is designed to support future development of a single nuclear rocket engine with 150,000-200,000 lbs. of thrust. This makes the engine relatively insensitive to mission variations from the Moon to Mars.

rocket program is directed to graphite solid core powerplants. This covers the KIWI work now finished and the NERVA program.

The last 18 months of graphite technology work has been extremely successful, says Klein. Out of some five reactor tests, a total operating time in excess of 120 minutes has been accrued. Of this, maximum design power levels totalled 40 minutes and one reactor alone accounts for more than 60 minutes of the total, with 16 minutes at maximum design conditions.

The demonstrated specific impulse is slightly greater than 750 sec. and Klein says the tests have conclusively demonstrated that the solid core system can do the job.

In reactor technology, the emphasis is on extending the operational lifetime, which means reducing hydrogen corrosion. The need is for 15 to 40 minutes of operation and laboratory work indicates this is possible.

The corrosion of graphite core components by hydrogen is a major problem. Klein says the solutions involve both the treatment of the graphite through coatings and design approaches which direct the hydrogen flow in order to minimize corrosive conditions.

The next area of effort is in understanding reactor behavior—such aspects as controllability and response. Klein says the reactors essentially steer "like a car" and tests to date have not uncovered any instabilities.

- **NERVA**—The NERVA reactor technology is represented by a unit operating at about 1,100 Mw with an altitude thrust rating of around 55,000 lbs. The technology of this reactor is now being fed into what is known as the Phoebus program.

The Phoebus effort is aimed at extending the capability of the NERVA reactor in terms of both temperature and power density. There are two segments to the Phoebus program.

Phoebus I will involve basically the same size hardware as that used in both the completed KIWI program and the continuing NERVA NRX projects. In general, Phoebus I will carry the technology up from the 1,100 Mw level. Phoebus II, or advanced Phoebus, has an ultimate aim of 5,000 Mw which translates to an altitude thrust of 250,000 lbs. in an engine application.

The Phoebus I tests, while involving current-size hardware, will have different details and structure. The program direction will also be oriented differently from the NRX units.

Phoebus II will be larger in size, but the size is chosen from mission applicability. Its size will not be directly related to the aim of a 2.5 increase in power density over the NRX reactors. The Phoebus II effort is so directed as to provide an adequate engine even if the ultimate power density is not reached. Laboratory analyses indicate a 5,000 Mw level can be reached but Klein says this remains to be seen. If the 5,000 Mw target is achieved, a lighter propulsion system would result for a net gain.

- **Upcoming tests**—The engine system technology portion of the nuclear propulsion effort is now focussed on an engine system test (EST) scheduled for next month, a subsequent experimental engine test (XE) (in which the unit would be down-fired for the first time), and non-reactor component work.

The EST involves the first close coupling of the hydrogen flow component to the NRX reactor. The turbopump will be driven by H_2 gas bled from the powerplant just prior to entering the nozzle throat.

The justification for the EST is that it is a minor extension in hardware over the NRX tests, yet will demonstrate a bootstrap start using the pressure relationship existing in the propellant tank and using the heat in the system itself. It will be a closed flow system. The interaction of the prime engine components will be demonstrated.

If the EST works out and poses no problems, the experimental engine tests following will primarily demonstrate the flight configuration, provide facility data and altitude conditions, since the test will be at a simulated altitude. All of this is needed for any full-scale nuclear engine development program.

The non-reactor component work is designed to get such items in a development state to support systems tests. Certain items such as the nozzle, pumps and control systems are development programs in themselves. Klein says the problems in these areas tend to be more conventional. The only question on actuation systems is radiation hardening. The actuators now in use are heavily shielded and the expectation is that less shielding would be used in actual flights. Work is in progress to bring these components to the flight design point.

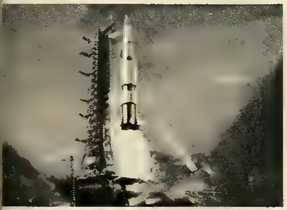
Stage technology is now at a low level. The primary work is on radiation effects. Since the nuclear engine uses hydrogen, all staging experience gathered in the chemical rocket area can be applied to the nuclear rocket.

At the moment, the staging, as well as engine concepts, is designed to fit the *Saturn V* launch system.

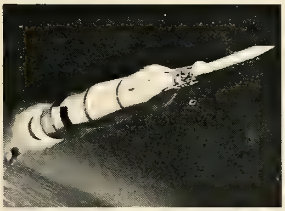
NEW CONCEPT

In addition to the graphite reactor, NASA and AEC have investigated a tungsten water-moderated solid core reactor concept. This work has been primarily materials oriented and is in its final stages at the Lewis Research Center. The Argonne National Laboratory handled the AEC portion of the program.

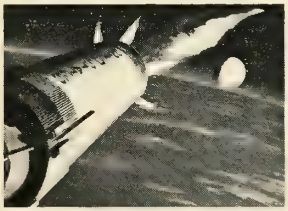
This is how American space pioneers will land on the moon and return to earth



Countdown. Atop the 30-story Saturn V rocket, three U.S. astronauts in Apollo command module prepare to be launched by 7,500,000 pounds of thrust. In 70 hours — the moon.



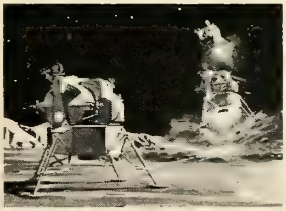
Ignition, stage two. At 200,000 feet, a brief jolt signals jettison of Saturn's first stage. Now the S-II second stage thrusts them ahead through the thin upper atmosphere.



Earth orbit. The S-II is left behind. The exhilaration of weightlessness begins as stage three powers them into orbit. At proper moment, stage three re-ignites. Next stop: moon.

Docking maneuver. On their way, they detach Apollo spacecraft, turn it to dock with the waiting Lunar Excursion Module (LEM). Saturn stage three is then jettisoned.

Lunar orbit. The moon draws incredibly near. Two astronauts enter the LEM. Apollo's service module engine slows them into lunar orbit. They peer at the surface 80 miles below.



Touchdown. The moment arrives. Separated from Apollo, LEM descends to the moon's surface. Soon these space pioneers may discover answers to questions as old as man.

Homeward bound. Their observations complete, they return in LEM to the Apollo, again fire service module engine. Returning to Earth will take three days. The LEM stays behind.

Safe landing. The atmosphere slows them. Three main chutes deploy. Mission ends with safe ocean landing. America reaps new knowledge, important new space capabilities.

The Apollo command module, service module, and the Saturn S-II stage are being built for NASA by North American/Space & Information Systems Division. North American Rocketdyne is building the rocket engines for all three stages of the Saturn V moon rocket.

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The tungsten reactor program consists of gathering all the information needed for an active development program, correlating and then shelving it for possible future use.

The reactor type itself is not new. General Electric Co. gave it considerable attention in the now defunct Aircraft Nuclear Propulsion program. NASA Lewis replaced the original nichrome fuel elements with tungsten to achieve a higher gas temperature and launched a reactor-rocket engine study.

As in a nuclear rocket, the hot tungsten fuel elements would be contained and insulated from a multiple aluminum tube arrangement. The fuel elements would be cooled by the flowing hydrogen propellant. The array of tubes along with the surrounding water moderator, constitutes the reactor.

In concept, an aluminum pressure vessel is completely filled with water except for the aluminum tubes containing the tungsten fuel elements and the flowing hydrogen. The hydrogen from the nozzle-cooling passages enters a water-hydrogen heat exchanger then flows into the reactor inlet plenum.

The hot hydrogen is expanded through the nozzle from this region, providing thrust.

- **Fuel elements studied** — The largest part of the tungsten core reactor is material- and fuel-element-oriented, and the principal work now in progress before the final wrap-up next year is in determining the properties, limits and capabilities of tungsten fuel elements.

The materials effort covered the examination of a broad range of uranium concentrations — from the lower amounts needed in a moderated reactor to the higher amounts necessary for a fast reactor. Klein says the work to date indicates the feasibility of fabricating fuel elements with uranium contents throughout the range of interest and to retain the uranium.

The tungsten reactor is not in competition with the graphite reactor, but the work by Lewis indicates the tungsten unit may be superior in applications demanding operating times of hours with many operating cycles.

Tungsten reactors may also be lighter in weight for low-thrust engines —in the 10,000-lb.-thrust regime—but such missions are not now evident.

There does not seem to be any significant specific impulse advantage over a graphite reactor for missions requiring operating times in the 30- to 40-minute range. Thus, the intent is to provide a reasonable technology base in tungsten reactors which allows the evaluation of performance potential so that such systems could be developed should mission needs be identified.

There is NASA interest in isotope-heated propulsion schemes for non-prime propulsion or possible application to scientific space probes. The technology in this area centers on getting isotope fuel forms in the 750-800° F temperatures of interest. Klein says there is no doubt such propulsion systems will work.

There are difficult problems in fuel forms, insulation and propellant flow and performance depends on how well these are solved. NASA is urging emphasis in this area to the AEC isotope people and Klein says the space agency is getting the needed cooperation. There is a possibility of tests in this technology using electrical heat sources being funded in the Fiscal 1967 budget.

ADVANCED CONCEPTS

The solid-core nuclear rocket has an upper specific impulse limit in the 800-second area. The next step in prime nuclear propulsion from a specific impulse standpoint "peels the next layer from the onion" says Klein.

The solid-core concept is limited by both materials and geometry in the fuel element area. The next generation would employ the nuclear fuel in discrete particulate form or as a liquid, or as a gas. These are the cavity reactors and represent a possible specific impulse in the 2,000 to 3,000-second regime.

But the problems are formidable.

Dr. John C. Evvard, Lewis Research Center, says the goal of gaseous-core nuclear rocket is to produce specific impulses above the 1,000-second mark with a thrust-to-weight ratio on the order of unity or larger. NASA is researching three major types of cavity reactors — dust-bed, liquid-core and gaseous-core—with the largest emphasis on gas since this type reaches the highest impulse.

Evvard says cost can be used as a measure of the required hydrogen-to-uranium flow ratio. (Fissionable gas is not retained in the cavity; a constant uranium/hydrogen mass flow enters and leaves the reactor. The problem is to increase the fuel residence time in the reactor over the hydrogen propellant.)

If it costs $200/lb. to place hydrogen in orbit and $7,000/lb. to produce uranium, this hydrogen-to-uranium weight ratio is 35 to 1. Evvard says a typical gaseous-core reactor might be 10 ft. in diameter and 10 ft. long.

A uranium partial-pressure of about 25 psi is required to maintain nuclear criticality. The hydrogen pressure should be as high as possible and Evvard takes 2,000 psi as reasonable. Thus the hydrogen-to-uranium mass flow would be 0.68, which is far below the required 35 to 1.

Hence, says Evvard, the residence time of the uranium relative to the hydrogen must be increased by a factor of 35/0.68 or 51.5. The struggle to find a good gaseous-core reactor concept revolves about this problem.

Given a good cavity reactor concept, says Evvard, the total weight of the reactor, including pressure shell and moderator would be from 250,000 to 500,000 lbs. In a mission comparison with more conventional nuclear rockets, the gaseous-core system would likely require a fuel load of more than 500,000 lbs. to capitalize on its higher specific impulse.

Thus, says Evvard, more than 1,000,000 lbs. in orbit would be required just for the engine and fuel load and the payload and structural weight have yet to be added.

At this point, Klein says it is not known if any cavity reactor is feasible. Since this is true, there are no firm projections allowing a reasonable guess as to thrust-to-weight ratios. And if this cannot be done, there is no real knowledge of performance.

Gaseous-core basic research is being funded at about the $1 million per year level by NASA. In addition to fuel residence problems, there is a need to transfer the fission energy efficiently to the propellant and to keep the critical mass and volume of fissionable material in reasonable bounds.

The research covers advanced notions of fluid mechanics, heat transfer and nucleonics. The theoretical performance of such propulsion schemes and the contribution of the research work to the general understanding of fluid mechanics provide a reasonable justification for the research effort.

- **Test ban a factor**—Another class of advanced concepts is nuclear pulse propulsion, such as that proposed for Project Orion. Klein says that the questions of the ability of materials to stand such high-energy shocks repetitively and other technical uncertainties are compounded by the nuclear test ban treaty.

In addition, Klein says partial system simulation may be feasible on the ground, but final systems development would have to be in space and this approach is not very attractive.

Then there is the fusion or thermonuclear propulsion system — which would, in theory, give thrust-to-engine weight ratios as high as 0.01 and correspond to about 1 or 2 kw of jet power per pound of engine weight with specific impulses in the 10,000 second area. Unfortunately, controlled fusion has not yet been obtained in a laboratory reactor, so rocket applications are in the very distant future. NASA is not working directly in this area.

Klein says the feasibility of any of these advanced concepts has yet to be determined and that their realizable performance is uncertain over a wide range. ■

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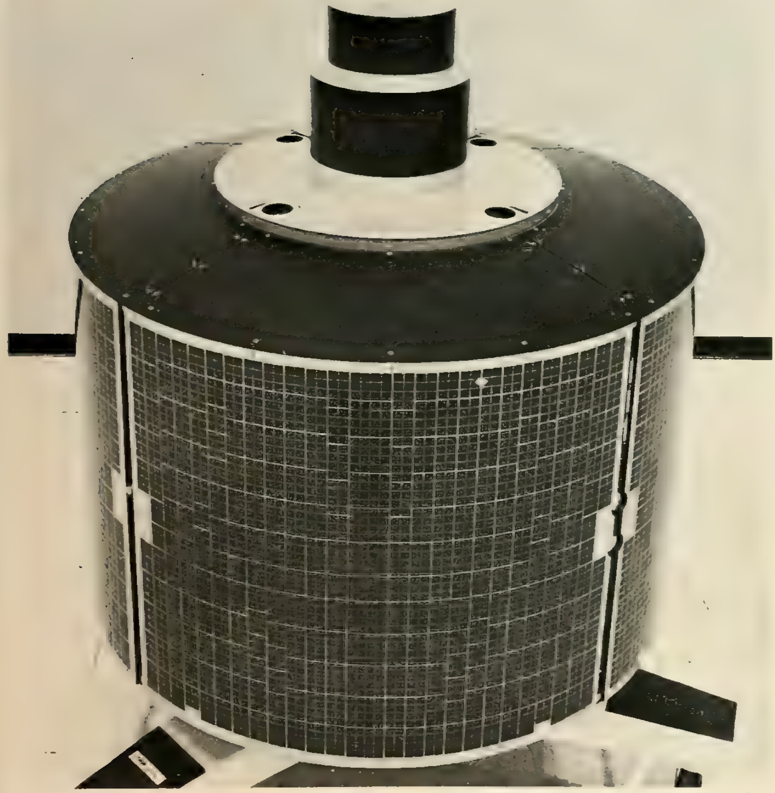
Global Network Operation Seen by '68

Satellite communications work progressing well; concepts are outstripping needs; NASCOM comsat should be operating in '66



TOP: TRW, Inc.'s contender for the follow-on global communications system satellite. Also in the competition are Hughes Aircraft Co., the developer of Early Bird, and Radio Corp. of America. BOTTOM: Hughes Aircraft's 150-lb. satellite will be used in Comsat Corp.'s NASCOM/interim communications satellite system.

A DECISION ON the final characteristics and configuration of the Communications Satellite Corporation's Advanced Global Comsat System will now be made no later than January, 1966.

However, this delay in finalizing system parameters, Comsat officials declare, will in no way affect selection of either the satellite or ground terminal system contractors.

Technical recommendations concerning the satellite system's developer were due from Comsat Corp.'s review staff on November 19, and were then to be directed upward for approval through the firm's management group. Final approval will then have to be made by the Interim Committee for Satellite Communications made up of representatives for the 46 nations participating in the global network.

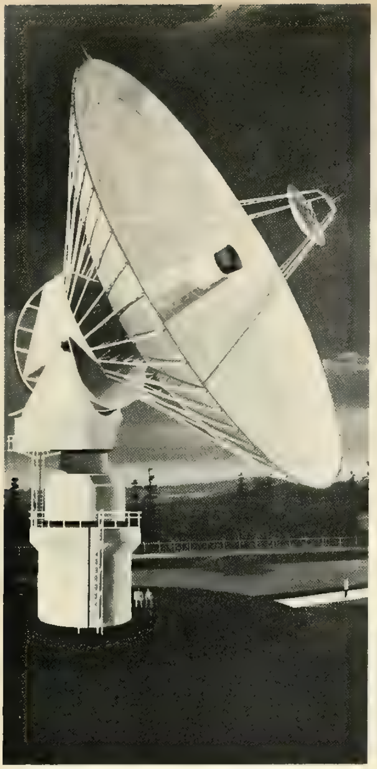
Contract award is expected by the early spring of '66, with six vehicles scheduled for delivery within 24 months of that time. The system should be operational by late 1968. (Three responses to the Comsat RFP's for an advanced satellite system issued last Aug. 18, have been received. Bidders are Hughes Aircraft Co.; TRW, Inc., teamed with International Telephone & Telegraph Corp.; and Radio Corp. of America.)

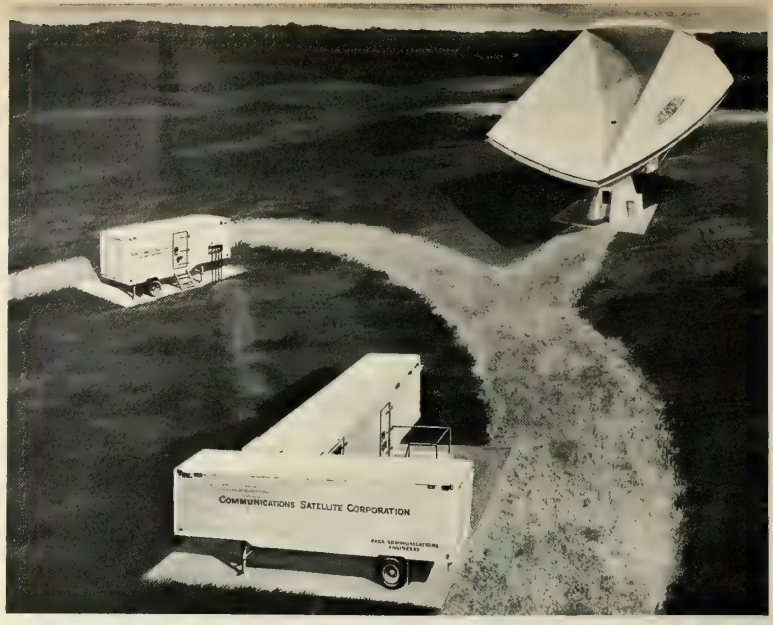
INTERIM SYSTEMS

Comsat's first experimental satellite, the *Early Bird*, was launched into an equatorial synchronous orbit last April 6, and has more than proven its worth. Serving as a test link connecting Western Europe and North America, it progressed rapidly from the role of a mere test bed to that of an operational commercial vehicle last June.

Circumstances have somewhat limited the Hughes-built vehicle from serving as a major communication relay. Out of its total 240-channel capability, only 70-odd channels have been leased from the Comsat Corp. This limited use reflects neither technical nor economic problems, but rather the practical effort by potential clients to make full use of existing cable capacity first, according to Comsat officials.

Some 80 to 100 channels will be leased by the end of this year and Comsat officials see a steady growth rate throughout 1966.





COMMUNICATIONS SATELLITE CORPORATION
PAGE COMMUNICATIONS ENGINEERS

LEFT: Comsat's 85-ft. paraboloidal-reflector antenna will be used with its two fixed commercial terminals at Brewster Flat, Wash., and Paumalu, Oahu, Hawaii. It will replace the initially used 42-ft. horns. ABOVE: Transportable Earth station developed by Page Communications Engineers, Inc., will be used by late next year on the NASCOM/interim comsat system. The 42-ft.-aperture Cassegrain reflector is produced by Keltec Industries, Inc.

Early Bird (F-1) is the first of two vehicles developed for Comsat Corp. by Hughes. The second *F-2*, stands ready as a replacement should the first vehicle suffer an early failure.

Ground stations currently serving as terminals for the relay satellite system are located an Andover, Maine (developed originally by AT&T for use with Bell Telephone Laboratories' *Telstar* experiments and now leased by Comsat Corp.); Goonhilly Downs, England; Pleumour-Bodon, France; Raisting, West Germany; and Fucino, Italy.

Designed for a minimum operating time of one year in orbit, Comsat hopes the craft will operate with at least a brief overlap of its follow-on system—the NASCOM/Interim Comsat System, already in development—due to be operational next year.

Should the system fail earlier than expected, and if at least 3-4 months remain before the next system is available, the *F-2* vehicle probably would be used.

• **NASCOM/interim comsat**—Often referred to of late as the *Apollo* Communications Satellite Program, the second system to be orbited will require two synchronous satellites, one over the Pacific and one over the Atlantic Ocean, and two back-up vehicles.

Funded in large part by NASA, the system is intended to serve as another part of the global NASA Communications (NASCOM) network, but is particularly needed to tie the *Apollo* Insertion and Injection Range Ships to the Goddard Space Flight Center. It also will serve to strengthen communications with those few NASA ground stations lacking good alternative routes for telecommunications.

In addition to providing voice and teleprinter communications for NASCOM, Comsat will also have an additional 100 channels available for commercial use. Thus, the system will be enlarged to provide service from Japan and other Pacific users to the U.S. in addition to the eastern link from the U.S. to Western Europe.

• **NASA program**—Earlier this year NASA, through Goddard Space Flight Center, approached Comsat with its overall requirements to enhance NASCOM circuit capability via satellite relay. The firm responded with a proposal to employ a two-satellite system with two back-up vehicles. One satellite was to be located at 130° East longitude, the other at 6° West longitude, and both in equatorial synchronous orbit. This has since been changed by NASA to 170° East longitude and 6° West longitude.

Comsat also proposed to employ the Andover, Me., terminal and to build new stations at Brewster Flat, Washington, and at Paumalu, Oahu, Hawaii.

Six other terminals complete the net: the three *Apollo* I&I Range Ships, in the Indian, Atlantic, and Pacific Oceans; and stations on Ascension Island, Grand Canary Island, and at Carnarvon, Australia, to be built and leased to NASA directly by the United Kingdom, Spain, and Australia, respectively.

The ships employ 30-ft. dishes, and the three other stations are expected to use 42-ft. antennas. Comsat has contracted with Page Communications Engineer, Inc., to provide two transportable terminals using 42-ft. aperture horns at Brewster Flat and Paumalu. (Australia reportedly will buy a third from Page for it Carnarvon site). The Page-built stations will be used until Comsat's two fixed terminals using 85-ft. dishes are completed at the Brewster Flat and Paumalu locations.

Comsat's contract with NASA is now being negotiated. In the meantime, the firm is proceeding with the program under a $6-million (for one year) letter of intent.

Reports vary on the ultimate size of the NASA award because of the many variables to be written into the contract. But conservative estimates are that the cost will be about $20 million over a three-year period.

Hughes Aircraft Co. provided the only response to the Comsat RFP

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for the four flight systems, possibly because it called for eight-month delivery of the vehicles from time of award. Contract is for $11.7 million.

- **Satellite design**—The new satellite will somewhat resemble *Early Bird* in configuration, but will be considerably larger. Measuring 56 in. in diameter x 26¼ in. high, the 150-lb. satellite will be provided with an Aerojet-General-developed Pathfinder apogee kick motor. The latter measures 18.7 in. dia. x 31.5 in. high and weighs 189.3 lbs.

Many of the electronic subsystems are the same as those ued in *Early Bird*, including the tunnel-diode travelling-wave tube (TWT).

NASA requires six alternative voice/data (2,400 bps) channels and two teleprinter channels.

For in-bound transmissions, from the *Apollo* spacecraft, for example, the six voice/data channels will provide: one for astronaut voice relay, one for high-speed tracking data, and three for high-speed telemetry. Out-bound channels will be the same for the first three channels but substitute command load for the TM channels.

The two teleprinter channels will carry standard 100-wpm traffic.

Four 6-watt TWT's will be required in the relay spacecraft. A maximum of three will be used at any given time, with one serving as a spare. Two will be for NASCOM and one for the commercial channels. Should one TWT fail, the commercial TWT would serve to back up the NASA channels.

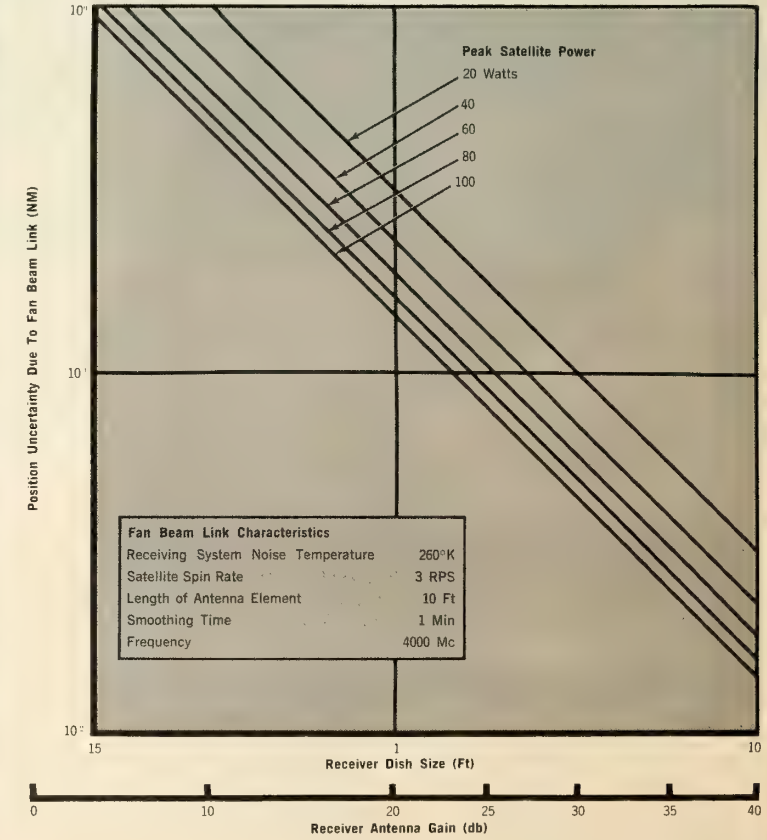
No communications link will be available in the system with the new *Apollo* range aircraft as they are presently to be equipped. This condition may be altered, however, after the craft are operational.

The system, under the present schedule, should be operating by September, 1966, in time to phase in with the range ships' completion during the October-January, 1967, period.

- **Global system**—The Comsat Corp.-proposed Global System satellite calls for a fairly flexible design such that the vehicle could be launched into a 0 to 30-degree inclination and from 8 to 24-hour orbits.

De-spun antenna's will be employed, according to Comsat, and a 16-db system gain will be sought. Two transponders, each using 6-watt TWT's, will be used in each vehicle.

Data from Philco's NavComSat reflects resultant fan-beam-link position uncertainty vs. receiver size.



Fan Beam Link Characteristics	
Receiving System Noise Temperature	260°K
Satellite Spin Rate	3 RPS
Length of Antenna Element	10 Ft
Smoothing Time	1 Min
Frequency	4000 Mc

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Space-Age Boeing Openings for Engineers and Scientists

The Boeing Company's deep involvement in the nation's most important space and missile programs is providing qualified engineers and scientists career opportunities of unusual scope and growth potential. Boeing currently is a major contractor on the NASA Saturn V launch vehicle and prime contractor for the NASA Lunar Orbiter moon-scanning satellite.

Launch Systems Branch openings are at Huntsville, Alabama; New Orleans, Louisiana, and Cape Kennedy, Florida, in research, design, development, manufacturing and test, and scientific and business computer technology. Requirements include a Bachelor's or advanced degree in an applicable discipline, plus related experience.

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SCIENTIFIC COMPUTER PROGRAMMING
LOGISTICS ENGINEERING
AEROSPACE PROGRAM PLANNING
TEST ENGINEERING
ELECTRICAL/ELECTRONIC DESIGN
CRYOGENICS
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STRUCTURES ANALYSIS & DESIGN
COMPUTER & LOGIC CIRCUIT DEVELOPMENT
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MANAGEMENT SYSTEMS STAFF

Send your resume to the employment manager at the installation(s) of your choice: Mr. L. S. Bonsteel, Boeing Atlantic Test Center, P.O. Box 1698-MTM, Cocoa Beach, Florida; Mr. John Hall, Boeing Launch Systems Branch, P.O. Box 1680-MTM, Huntsville, Alabama, or Mr. L. Wendell Hays, Boeing Launch Systems Branch, P.O. Box 29100-MTM, New Orleans, Louisiana 70129.

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UNIQUE DUAL-CROSS-BEAM transmission would be directed from medium- or synchronous-altitude satellite to Earth in a Philco Corp. concept for a navigation-communications satellite system proposed to NASA.

Comsat's two new Earth stations are expected to cost about $6 million each. Construction will begin by the end of the year, and both stations are due for completion by the end of 1966.

Both sites will be capable of expansion in the future as the number of space relay stations increases. Each will be capable of employing up to five antennas.

FUTURE SYSTEMS

The rapid expansion of global communications by means of active satellite relay seems assured if predictions by today's experts hold at all valid. They have predicted a continuous growth rate in international telecommunications of 20% or more per year.

One NASA spokesman, testifying before Congress several years ago, forecast an overseas-telephone-call growth from 4 million in 1960 to 20 million by 1970 and to 100 million by 1980.

Others have estimated that by 1980 up to two-thirds of the world's telecommunications will be conducted using satellites.

A more pertinent question might be what kind of future communications satellite systems will be permitted or is really needed (excluding those designed specifically for military use).

The American Broadcasting Co., has filed a request with the Federal Communications Commission to authorize development and operation of a television-distribution satellite system.

United Press International has shown interest in a system for gathering and sending news and photos.

Federal agencies and U.S. trade associations have expressed considerable interest in special satellite systems.

The Air Transport Association, has been working with Comsat Corp., Boeing, Bendix, Pan American, and Hughes on the problem of improving air-to-ground VHF voice communications via satellite. Test operation using *Syncom III* has been achieved.

NASA and the Federal Aviation Agency have shown continued interest in the improvement of air traffic control, air-to-ground communications, and navigation through the use of satellites.

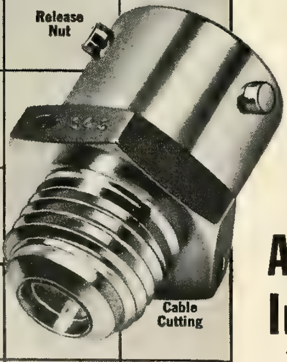
So far the FCC has looked with jaundiced eye on most of these proposed schemes and, many feel, for good reason. The Commission rightly looks on the use of the radio spectrum as a national resource. Its approach has been to avoid duplication and unnecessary exploitation.

Comsat officials have pointed out that for many schemes already proposed there is difficulty in isolating and identifying the customer to be served and the sources of an assured return on investment.

Others have urged that commercial systems of the future provide a multifunction capability rather than specialized service.

It also is probable that some multipurpose systems designed for a specialized group (e.g., the common air carriers) may have to be Government-funded and -operated.

● **Hughes' advanced concepts**—Typical of the forward thinking in industry today, as firms seek to establish



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"Little Joe II" Motor Ignition	Release Nut	
Launch Escape Motor Ignition		
Pitch Control Motor Ignition		
Detonator		Cable Cutting
Canard Thruster	Pyrotechnic Actuated Switch	Pyrotechnic Actuated Valve
Escape Tower Jettison Motor Ignition	Drogue Parachute Deployment	Drogue Parachute Disconnect
F.L.S.C. Detonation	Detonator	Main Parachute Disconnect

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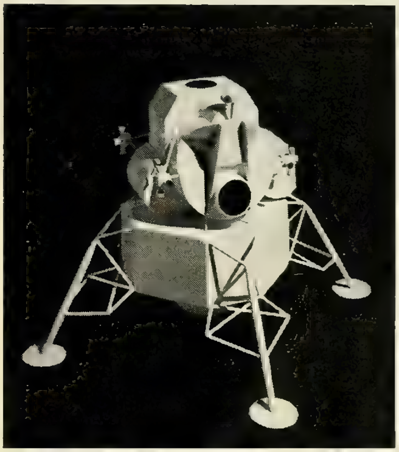

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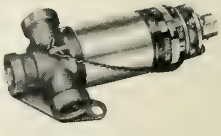

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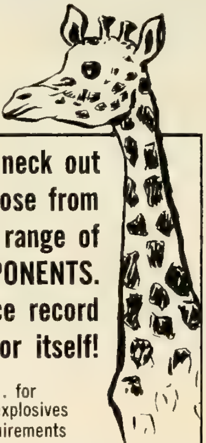

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themselves in the communications satellite field and create new markets, are Hughes' proposed advanced satellite systems.

Development of a 1,550-lb. highly advanced synchronous satellite system has been forecast by Dr. Harold A. Rosen of Hughes' Space Systems Div.

Suggesting essentially a system providing direct space-to-home video broadcast reception, Rosen estimated that stamped aluminum dishes could be made available for under $40 each, home TV set conversion for less than $100.

A 7-ft.-dia. x 6-ft.-high satellite would be required, he said, capable of relaying perfect color or black and white TV programs anywhere except to the outer polar regions of the Earth.

Cost to a TV network, he estimated, to own and operate such a satellite would be roughly $10 million, including launch costs and orbit support. This cost, he asserted, could be amortized over the five-year life of the satellite.

The earth station transmitting to the satellite would cost less that $1 million, said Rosen.

Present effective radiated power (ERP) in communications satellites might be increased an order of magnitude through the use of a highly directive antenna for transmissions to ground, Rosen declared.

A phased-array, Rosen pointed out, could be used employing sixteen elements arranged about the spin-axis. Driven in proper phase to form a pencil beam, it would be de-spun electronically.

To use effectively the higher ERP, bandwidth would be increased proportionately. An all-microwave repeater would make greatly extended bandwidths practical and permit simultaneous access by many ground terminals without sacrificing communications capacity, he said.

● **Philco NavComSat** — A single, potentially reliable concept for a navigation-communication satellite system that could be used by aircraft as well as surface vessels has been proposed to NASA by the Philco Corp.'s Western Development Laboratories Division.

Dr. Stanley F. Schmidt, staff scientist at the Palo Alto, Calif., facility, is originator of the approach, which involves a passive technique for navigational fixes, but could also be employed for specialized communications relay to and from fixed land stations.

In the Philco concept, a network of spinning satellites at either medium or synchronous-altitude orbits would be used. Each would direct two right-angle intersecting fan-shaped beams to Earth. In addition, a reference pulse would be transmitted.

A position fix would be obtained at

the receiving surface vessel or aircraft by measuring, either automatically or manually, the time interval between the intersection of the fan beam with the craft and the reference pulse. The measurement, Schmidt asserts, is simple electronically and yet produces a high resolution.

Generation of the reference pulse could be accomplished either by the satellite's using a star sensor or from a ground control center via the satellite. Also, additional navigational computational data could be relayed from ground centers or directly transmitted from onboard stored data in the satellite, Schmidt said.

The argument for a passive-navigation mode system, Philco stresses, is that access would be available to an unlimited number of users simultaneously with no effect on the communications function of the system. For military craft, passive operation might be a requirement to avoid revealing position. (The existing *Transit* navigation satellite also employs a passive concept, but the equipment needed at the receiving end must necessarily be complex and expensive.) Repeated fix-determination could further improve accuracy.

Other systems proposed and being studied for NASA (see Applications Satellite Programs on p. 91) require interrogation of the satellite by the user and provide limited simultaneous access.

The Philco system would require only a small two-channel receiver. Position could be calculated manually, if cost were a major factor, Schmidt pointed out.

Possible applications for such a system, according to developers, include air traffic control, weather data relay, air-sea rescue direction, and navigation-hazard warning services.

The biggest problem (already noted) is whether or not a real need for such a system can be established.

To justify such a system, according to Philco, the specialized-service system must provide improvements in:

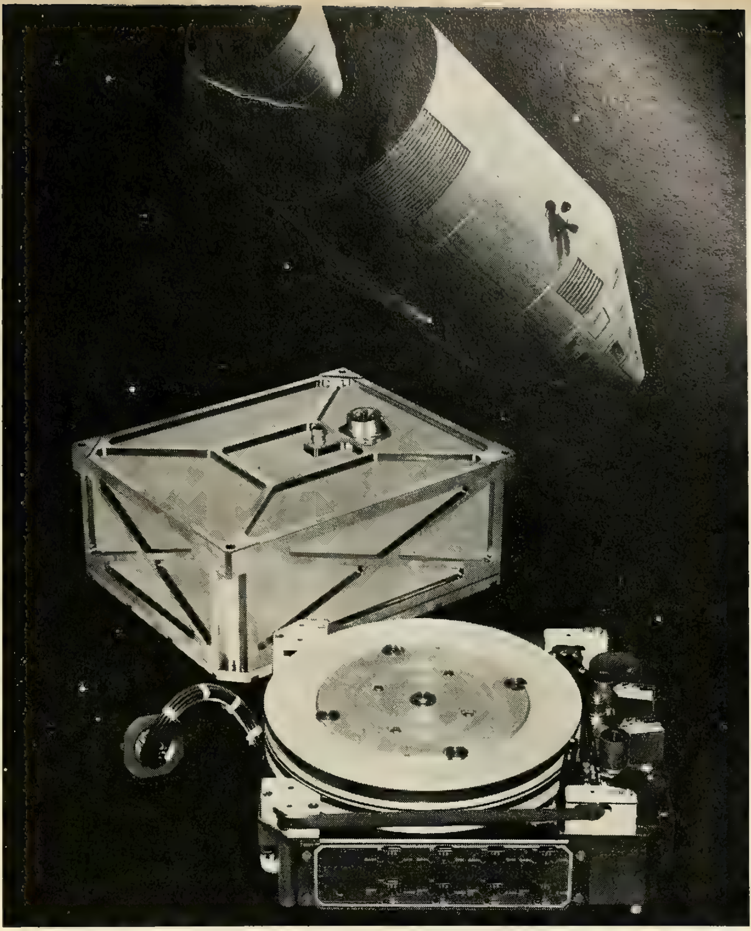
1) Aircraft communications reliabilty and in air traffic control, particularly over the high traffic density transoceanic routes;

2) Sea search-and-rescue operations for aircraft and ships in distress;

3) Methods of transmitting and receiving data on potential hazards to transport operation (e.g., weather, icebergs, traffic congestion);

4) Navigation-fix equipment including higher accuracy, reduced costs, extended coverage, and higher reliability.

The system would have to be designed such that, within a tolerable range, performance and accuracy requirements of the user might be traded for lowered equipment costs and complexity. ■



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contracts and procurements

AWARDS

AIR FORCE

$20,175,357—**Boeing Co.,** Seattle, first segment of a $89,932,403 contract to make and install *Minuteman* intercontinental missiles.

$8,600,000—**Raytheon Co.,** Lexington, Mass., first segment of a $11,440,000 contract for work on an instrument system to test weapons.

$6,565,761—**Kollsman Instrument Corp.,** Elmhurst, N.Y., from the Aeronautical Systems Div. for spare parts.

$5,000,000—**Sylvania Electric Products, Inc.,** New York City, to install antennas for radio communications among 165 Air Force *Minuteman* missile sites in North Dakota.

$3,042,000—**Atlantic Research Corp.,** Alexandria, Va., for work on high-altitude weather rockets.

$2,528,533—**North American Aviation, Inc.,** El Segundo, Calif., to overhaul *Hound Dog* air-to-ground missiles in Anaheim, Calif.

$2,470,000—**Lear-Siegler, Inc.,** Santa Monica, Calif., to make flight-control components for the *Firebee* target missile.

$1,424,072—**Hewlett-Packard Co.,** Palo Alto, Calif., to produce electronic test sets.

$1,192,894—**General Electric Co.,** Philadelphia, to develop and test space vehicles.

$700,000—**General Dynamics Corp.,** Pomona Div., Pomona, Calif., for re-entry vehicle impact investigation at Naval Ordnance Test Station, China Lake, Calif.

$510,000—**General Aniline and Film Corp.,** New York City, to develop an advanced microdensitrometer system for photometric analysis of fine detail contained in photographic films and plates.

$350,198—**Massachusetts Institute of Technology,** Cambridge, Mass., for research on seismology. Also, $35,379 for study of insteady gas dynamic problems related to flight vehicles.

$199,782—**California Institute of Technology,** Pasadena, Calif., for research on stellar composition and nuclear processes.

$146,244—**Minnesota Mining and Manufacturing Co.,** St. Paul, Minn., for development of a high-density binder for solid propellants.

$94,782—**Flow Technology, Inc.,** Tempe, Ariz., for a Flowmeter prover system from the Rocket Propulsion Lab., Research and Technology Div., at Edwards AFB.

$91,973—**Thiokol Chemical Corp.,** Huntsville Div., Huntsville, Ala., for investigation of the mechanism of solid-propellant burn rate.

ARMY

$8,096,310—**General Dynamics Corp.,** New York City, for engineering work on the *Redeye* air defense missile system in Pomona, Calif.

$3,400,000—**Gibbs Manufacturing & Research Corp.,** Janesville, Wis., for rocket fuzes.

$1,390,904—**Raytheon Co.,** Lexington, Mass., to produce ground-support equipment for the *Hawk* missile sytem in Andover and Waltham, Mass.

$485,967—**Akwa-Downey Construction Co.,** Milwaukee, Wis., for an environmental shelter for final checkout of the *Titan III-C* vehicles and their payloads on the launch pad.

$100,000—**Fairchild Hiller Corp.,** Stratos Div., Bay Shore, N.Y., contract extension to fabricate advanced environmental control systems for future field evaluation.

NAVY

$6,195,200—**American Telephone & Telegraph Co.,** New York City, for oceanographic research.

$4,300,000—**North American Aviation, Inc.,** Autonetics Div., Anaheim, Calif., to build 20 electronic checkout systems for E2A Hawkeye early warning aircraft.

$3,000,000—**Newport News Shipbuilding & Dry Dock Co.,** Newport News, Va., for alteration of a *Polaris* missile submarine.

$1,533,554—**Sperry Rand Corp.,** New York City, to make computer equipment.

$60,000—**Douglas Aircraft Co.,** Missile & Space Systems Div., Santa Monica, Calif., for missile heating study.

NASA

$435,000—**Systems Engineering Laboratories, Inc.,** Ft. Lauderdale, Fla., from Flight Research Center for data acquisition system.

$270,000—**Martin Co.,** Denver, from Manned Spacecraft Center at Houston, to investigate ways of performing on-board checkout of experimental equipment during the space flight of the *Apollo* service and lunar excursion modules.

$219,965—**International Latex Corp.,** Government and Industrial Div., Dover, Del., from Manned Spacecraft Center for *Apollo* pressure garment assemblies.

$99,000—**Avco Corp.,** Research and Advanced Development Div., Wilmington, Mass., from Manned Spacecraft Center to test the reliability of the radio communication systems which will link the *Apollo* spacecraft with those on Earth monitoring the journey to and from the Moon. Also, $89,000 to evaluate the thermal properties of spacecraft materials.

$93,392—**Bell Aerospace Corp.,** Buffalo, N.Y., from Manned Spacecraft Center for aluminum ring stiffened *Apollo* configuration RCS propellant shell.

$83,177—**General Dynamics Corp.,** Electronics Div., Rochester, N.Y., from Goddard Space Flight Center for a four-channel advanced polarization diversity autotrack receiver.

$66,573—**Collins Radio Co.,** Dallas, from Goddard Space Flight Center for antenna pattern studies for the Radio Astronomy Explorer.

$60,615—**Bendix Corp.,** Cincinnatti, Ohio, from Ames Research Center for time of flight mass spectrometer.

$27,682—**Electronic Associates,** West Long Branch, N.J., from Lewis Research Center for computer equipment.

$20,162—**Planning Research Corp.,** Los Angeles, Calif., from Headquarters for increased effort in the study of the geodetic satellite.

INDUSTRY

$15,000,000—**Raytheon Co.,** Lexington, Mass., from **American Telephone & Telegraph Co.,** Bell Telephone Lab., New York City, additional funding for continued development of missile-site radar for the *Nike-X* antimissile system.

$1,540,000—**Anderson Electric Corp.,** Leeds, Ala., from **General Electric Co.,** New York City, for the fabrication of program distributors for use in ground support for the *Saturn* program.

$400,000—**U.S. Polymeric Chemicals, Inc.,** Santa Ana, Calif., from **Aerojet-General Corp.,** El Monte, Calif., to supply high-tensile-strength prepreg roving used in the filament wound *Polaris A3* first stage rocket motor case.

Milgo Electronic Corp., Miami, Fla., from **McDonnell Aircraft Corp.,** St. Louis, Mo., analog computer for hybrid applications.

PROCUREMENTS

REQUESTS FOR BIDS

NASA
Manned Spacecraft Center
General Research Procurement Branch
BG831
Houston, Tex. 77058

Will negotiate with Atlantic Research Corp., Alexandria, Va., for an addition to contract NASA-9-4494. This addendum provides a study to determine the adhesive effects of propellant freezing in a *Gemini* thruster engine. For information only; RFP not available.

Fort Monmouth Procurement Division
Procurement and Production Directorate
United States Army Electronics Command
Fort Monmouth, N.J. 07703

Award is being made to Philco Corp., Philadelphia, to continue research work. Services are to include further investigation of visual communications techniques. For information only; RFP not available.

Procurement and Contracts Division NASA
Manned Spacecraft Center
Houston, Tex. 77058

Conducting negotiations with GCA Technology Div., GCA Corp., for Earth based lunar atmospheric studies. For information only; RFP not available.

Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135

Negotiations will be conducted with Electro-Optical Systems, Inc., Pasadena, Calif., for continued testing of an ion thrustor system—PR 202889. For information only; RFP not available.

Directorate of Procurement
Deputy for Materiel, Air Proving Ground Center
Eglin Air Force Base, Fla. 32542

A continuation of work under contract AF 08-(635)-4374 for submissile deployment fuze is contemplated with Philco Corp., Aeronutronic Div., Newport Beach, Calif., purchase request AFS 66-159. For information only; RFP not available.

USAMICOM
Redstone Arsenal Alabama
Attn: Procurement and Production Directorate

Research and development contract providing for continued development of *Chaparral* missile system by Aeronutronic Division of Philco Corp., Newport Beach, Calif. Those interested in sub-contracting make direct contact with the firm.

Directorate of R & D Procurement
Systems Engineer Group RTD
Wright-Patterson AFB, Ohio 45433

It is contemplated that negotiations will be conducted with Korad Corp., Santa Monica, Calif., for a program to increase the efficiency of laser operation through sensitized fluorescence. For information only; RFP not available.

Directorate of R & D Procurement
Systems Engineer Group RTD
Wright-Patterson AFB, Ohio 45433

It is anticipated that negotiations will be conducted with Space General Corp., El Monte, Calif., for continuation of exploratory development of MOL experiment S-6. For information only; RFP not available.

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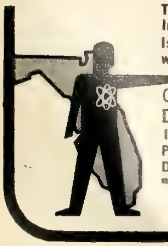

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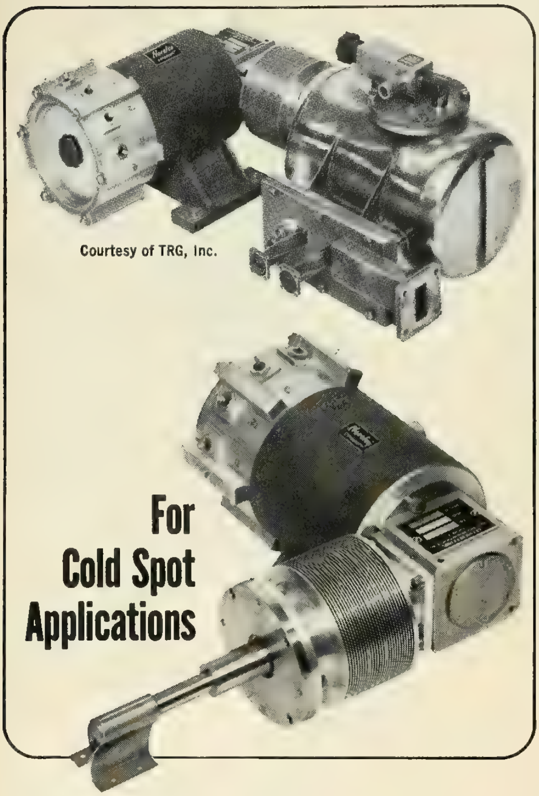

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names in the news

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Dr. Harry J. Watters: Appointed division vice president, defense engineering, RCA Defense Electronic Products. Formerly chief defense engineer, he will continue to be responsible for RCA's Applied Research, Systems Engineering, Evaluation, and Research and Defense Microelectronics activities.

Leonard J. Corti: Appointed vice president and director of planning for the Guidance and Control Systems Div. of Litton Industries. He joined Litton two years ago as director of administration for the Guidance and Control Systems Div.

Dr. Jack A. Green: Joined the staff of the Douglas Aircraft Co.'s Advanced Research Laboratory. He will continue his studies of the origin and character of the Moon and the planets.

Brig. Gen. William R. Yancey: Named Vice Commander of Aeronautical Systems Division at Wright-Patterson AFB. He succeeds **Brig. Gen. H. B. Manson,** who now is serving as Commander of the Research and Technology Division's Systems Engineering Group.

D. A. Graham: Named vice president and controller of Sperry Rand Corporation's UNIVAC Div. He will be responsible for division-wide operations and will report directly to the president of the division.

Dr. Raymond M. Warner, Jr.: Joined Texas Instruments Semiconductor-Components Div. He will head a major program for TI's Semiconductor and Research and Development Laboratories.

Robert R. Butcher: Appointed senior regional representative for the Washington office of Northrop Space Laboratories. He has been associated with Air Force and NASA spacecraft programs at Northrop, most recently as chief of systems engineering on the *OV2* satellite series.

D. Schwarzkopf: Named vice president for International Operations and Engineering at Unimax Switch Division of Maxson Electronics Corp. **A. J. Schweitzer** appointed vice president, marketing and **E. Currlin** named vice president, manufacturing.

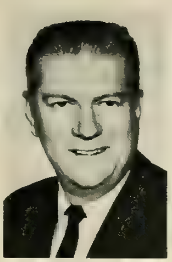
Frederic A. Wyatt: Appointed director of the Dyna-Therm Corp. He is a management consultant, and was chosen to recruit and select the technical staff responsible for designing the reactor and propulsion equipment for the Navy's nuclear submarine program.

Arthur A. Burgess, Jr.: Named director of marketing, Aerospace Systems Div. of Scientific Data Systems. He will oversee the marketing of space instruments.

Delos W. Rentzel: Elected a director of the Martin Marietta Corp. A Martin Marietta vice president, he serves as president of the Cement and Lime Div. He was administrator of the Civil Aeronautics Administration from 1948 to 1950.

Capt. Joseph S. Burkle: Appointed deputy director of the Armed Forces Radiobiology Research Institute. The AFRRI investigates the effects of ionizing radiation on biological systems with particular emphasis on better understanding its effect on man.

YANCEY



GRAHAM

WARNER

Joseph Hoinowski: Named vice president and general manager of the Maxson Ordnance Div. of Maxson Electronics Corp.

Edwin M. Dexter: Appointed vice president of Bowles Engineering Corp. He will have responsibility for directing all of the firm's engineering operations.

John S. Fondrk: Joined the staff of the Government and Industrial Systems Div., Operations Research Incorporated, as a senior physicist.

Walter Gottesman: Elected to the board of directors of Tenney Engineering, Inc. He joined Tenney in 1952 and became assistant secretary in February, 1959. He has served since the end of that year as secretary.

Harry Dornbrand: Named director of engineering for Fairchild Hiller's Space Systems Division. **John S. Kerr** has been appointed manager of marketing for the division.

Thomas H. Bay: Appointed general manager of Fairchild Instrumentation, a division of Fairchild Camera and Instrument Corp. He replaces **John Auld,** who has been reassigned to the corporate executive staff.

John Horrigan: Joined Varian Associates Bomac Division as senior engineer. He will play a part in the development of magnetrons used in various advanced space programs.

Edmund F. Lapham, Jr.: Appointed manager of technical operations of the Bendix Mishawaka Division of the Bendix Corp. He will be responsible for the engineering, advanced programs, long-range planning and marketing activities of the division.

Lynn R. Barton: Appointed a senior member of the technical staff at ITT Corp., Federal Laboratories. He will be concerned with circuit design in communication systems.

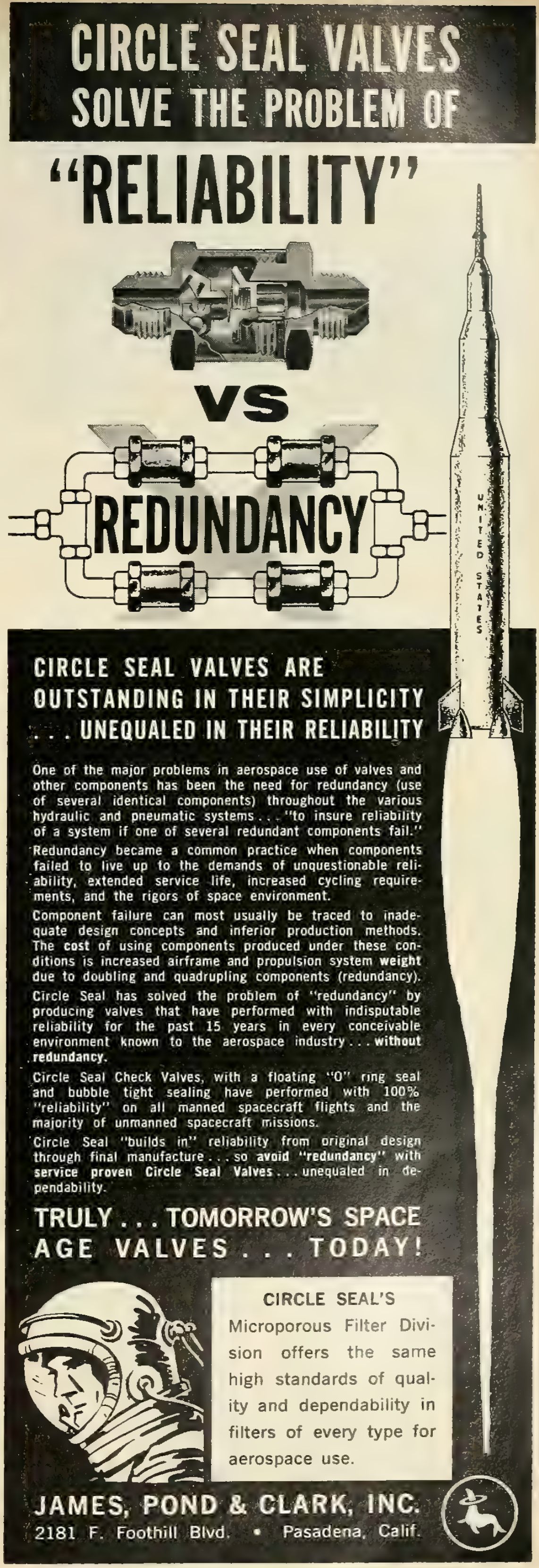
Robert J. Covino: Appointed applications engineer for RF products and subsystems packages by Adams-Russell Company, Inc. He will be responsible for customer-liaison in connection with Adams-Russell's RF devices and subsystem circuits.

Kenneth Wayne Whitt: Joined the staff of the Center for Naval Analyses of the Franklin Institute. He has been assigned to the Systems Evaluation Group.

Richard E. Marsh: Named as project manager-electronics of Pollak and Skan, Inc. He will be responsible for electronic product development including nuclear and radiation equipment, measuring and test instruments, microwave components, radar equipment, and computers.

Dr. Carroll L. Zimmerman: Elected to the Council of the Military Applications Section of the Operations Research Society of America. He is director of Aerospace Sciences for the Douglas Aircraft Group.

Ralph H. Flynn: Appointed director of Publications Services of the Institute of Electrical and Electronics Engineers. He will be responsible for directing all business and advertising aspects of the Institute's publications.



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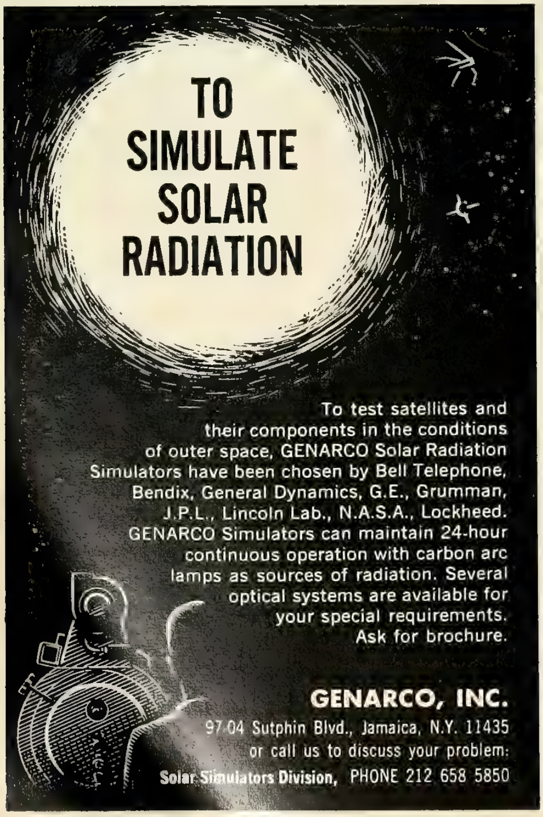

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when and where

First Annual Conference on Operating Metallurgy, sponsored by by the Metallurgical Society, Penn-Sheraton, Civic Arena, & Exhibit Hall, Pittsburgh, Nov. 29-Dec.3.

1965 Ultrasonics Symposium, sponsored by the Group on Sonics and Ultrasonics of the Institute of Electrical and Electronics Engineers, Hotel Sheraton-Boston, Boston, Dec. 1-3.

1965 Fall Computer Conference, Convention Center, Las Vegas, Nev., Nov. 30-Dec. 2.

Vehicular Communications Conference, sponsored by the Institute of Electrical & Electronics Engineers, Sheraton-Park Hotel, Washington, D.C., Dec. 2-3.

American Chemical Society Southeast-Southwest Regional Meeting, sponsored by the American Chemical Society, Peabody Hotel, Memphis, Tenn., Dec. 2-4.

Sixth Annual Symposium on Filament Structures Technology, sponsored by the American Society of Mechanical Engineers, New Mexico Section and the University of New Mexico, University of New Mexico student union building, Albuquerque, Dec. 3-4.

Cutler-Hammer Symposium, sponsored by Cutler-Hammer, Inc., Hotel Pfister, Milwaukee, Wis., Dec. 4.

American Institute of Chemical Engineers 58th Annual Meeting, sponsored by the American Institute of Chemical Engineers, Bellevue Stratford Hotel, Philadelphia, Dec. 6-10.

Eighth Annual Army Aviation Contract Services Symposium, sponsored by the National Aerospace Services Association, Washington, D.C., Dec. 6.

NSIA/AFSC Microelectronics Conference on "Applications of Microelectronics Technology," sponsored by the National Security Industrial Association and the Air Force Systems Command, Sheraton-Park Hotel, Washington, D.C., Dec. 8-9.

National Defense Transportation Association's Regional Defense Transportation Conference, sponsored by the National Defense Transportation Association, New York Hilton Hotel, New York City, Dec. 9.

American Association for the Advancement of Science 132nd Annual Meeting, sponsored by the American Association for the Advancement of Science, University of Calif., Berkeley, Dec. 26-31.

National Society of Professional Engineers Winter Meeting, sponsored by the National Society of Professional Engineers, Americana Hotel, Miami Beach, Fla., Jan. 5-8.

American Chemical Society National Winter Meeting, sponsored by the American Chemical Society, Phoenix, Ariz., Jan. 16-21.

Third Coral Gables Conference on Symmetry Principles at High Energy, sponsored by the University of Miami, Air Force Office of Scientific Research, Atomic Energy Commission, National Aeronautics & Space Admin., National Science Foundation, and Office of Naval Research, University of Miami, Coral Gables, Fla., Jan. 20-22.

Society of Plastics Engineers Regional Technology Conference, sponsored by the Society of Plastics Engineers, Cleveland Section, Sheraton-Cleveland Hotel, Cleveland, Jan. 20.

Third Aerospace Sciences Meeting, sponsored by the American Institute of Aeronautics & Astronautics, New York City, Jan. 24-26.

Symposium on Electrification of Machinery, sponsored by the Institute of Electrical & Electronics Engineers, Worcester Section, Wachesett Country Club, W. Boylston, Mass., Jan. 25.

Engineering & Operations Workshop, sponsored by the American Public Power Association, Roosevelt Hotel, New Orleans, La., Jan. 25-28.

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editorial . . .

Harvest Moon

ESCALATION OF THE WAR in Vietnam, in addition to its other bitter fruit, is forcing the Administration into a cautious appraisal of its spending in all other areas of the budget.

Defense needs compete with the demands of the war on poverty, the foreign aid program, the Peace Corps and urban renewal—and with the requirements of the National Aeronautics and Space Administration.

NASA's budget for space exploration itself competes with other areas of science and technology which offer attractive returns for Federal spending.

This, of course, is always true of the budget process, even without the added pressure of a Vietnam. It is particularly true of new programs.

In the space field, imagination is required, always, to foresee those things which can be done. In today's circumstances, more than ever, great wisdom must be used to determine those things which should be done.

NASA now possesses the competence in space technology to set off in many directions with reasonable assurance of success. The harvest of the time and money spent since the birth of the space agency is at hand. But the closest study and forethought is needed to establish the priorities on which the fruit is to be picked.

Wisely, the Administration last year told NASA to focus its attention first on those projects which could be carried out by hardware currently under development. The *Apollo* spacecraft and its *Saturn* booster were to have maximum utilization.

The space agency has done that, and the *Apollo* Applications program is the result. Funding for first-year development of the AA program is in the NASA budget proposed for Fiscal 1967. A program is outlined which may eventually cost $6 billion, a modest figure in comparison with the manned lunar-landing project which precedes it and makes it possible.

The AA schedule calls for 28-day orbital flights around the Moon, 14-day exploration missions on the lunar surface and 14- to 45-day flights in Earth orbit. Experiments planned for these missions span the scientific spectrum.

Marshall Space Flight Center is expected to issue, before the end of the year, a request for proposals on systems definition of a major part of the AA project.

Work on the *Apollo* Applications program is, therefore, already well in hand. NASA would like to have $400 million in the FY '67 budget to initiate hardware development. Talks with the Bureau of the Budget, however, have made it clear that it is unlikely that more than $200 million can be devoted to AA, if that. NASA would like to have $5.6 billion in its FY '67 budget; the Administration does not want the agency to go above this year's request of $5.26 billion. There is even some talk of a reduction to $5 billion or below.

What do these various budget levels mean to the *Apollo* Applications program? At $5.6 billion, AA would get the $400 million which NASA wants to start the program; at $5.26 billion, there would be $200 million for AA; at the $5-billion figure, there would be no funds for the project.

It is not for us to pass on the question of whether *Apollo* Applications requires $400 million or $200 million in the next fiscal year. We can point out, however, the hazards of failing to initiate the project on schedule and of failing to provide an adequate level of funding.

It is often forgotten that NASA was well along with the *Mercury* project before there were any firm plans for the *Gemini* program. *Mercury* was, at that time, a dead-end project with no follow-on. The result of this lack of foresight was painfully evident in the long gap in the U.S. manned spaceflight program between the last *Mercury* flight and the first *Gemini* manned flight. The existence of the gap was made abundantly clear by the continuing Soviet launches.

In programs with such long leadtimes, planning must be carried out in the full knowledge of what schedule delays or funding cutbacks can mean to the manned spaceflight program years from now.

CERTAINLY, THE U.S. will not end its manned exploration of space with a landing on the Moon. The initial lunar excursion is the beginning, not the conclusion, of the reach for the stars. Since that is the case, the next logical step is the manned surface and orbital exploration of the Moon called for in the *Apollo* Applications program. But schedules must be firmed up, contractors selected, hardware development initiated.

If these things are not done now, there will be a pointless gap between the initial landings on the Moon and the scientific exploration of that body.

Apollo Applications is not the only important program which would be endangered by severe cuts in the NASA budget request. Certainly, there is nothing sacred about the space agency budget, but any cutting must be done in full knowledge of what it may mean.

NASA Associate Administrator Robert C. Seamans, Jr., recently outlined the dangers:

"The capability now coming on stream cannot be mothballed. We must use it or see its value erode. With it, we are not where we were in 1957 but in a position from which we can move into even more challenging areas of exploration in aeronautics and space. If we do not use what we have created, continued expansion of the Soviet program will very likely lead to future Soviet missions that will have the impact of *Sputnik I*. If we retrench, we may not be able to develop scientific information and advanced technology in time to meet the requirements of other agencies of the Government and U.S. industry. If we retrench, we will not continue to energize large segments of the scientific community. If we retrench, we will not have the capability to bring our new and powerful resources to bear upon critical problems outside of the immediate space area."

In pruning the NASA budget request—and undoubtedly it can be pruned—the Administration and the Congress should cut with the delicacy of the scalpel, not the brutal hack of the axe. Dr. Seamans has succinctly spelled out the reasons why.

William J. Coughlin

Gemini Spacecraft
UNITED STATES
Whether launched before a watching world . . .
. . . or from a carrier deck in the China Sea,
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From an original painting for Chandler Evans by Keith Ferris

CECO Main Fuel Pumps Selected for the FAN JET FALCON

Pan American's Fan Jet Falcon (built by Dassault) is a 500-plus m.p.h. business jet transport. This 12-place executive time-saver is powered by two General Electric CF-700 engines equipped with main fuel pumps engineered and precision-produced by Chandler Evans.

This CECO product on the Falcon joins a distinguished line of pumps, main fuel controls, afterburner controls and other jet engine components in an array of important military aircraft and missiles as well as many of the latest and finest commercial aircraft.

Chandler Evans is pleased to be "known by the company its products keep" and by the records those products establish.

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DECEMBER 6, 1965

missiles and rockets

THE WEEKLY OF ADVANCED TECHNOLOGY

DEC 1965
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AF Seeking Go-ahead for 'Maverick' Missiles

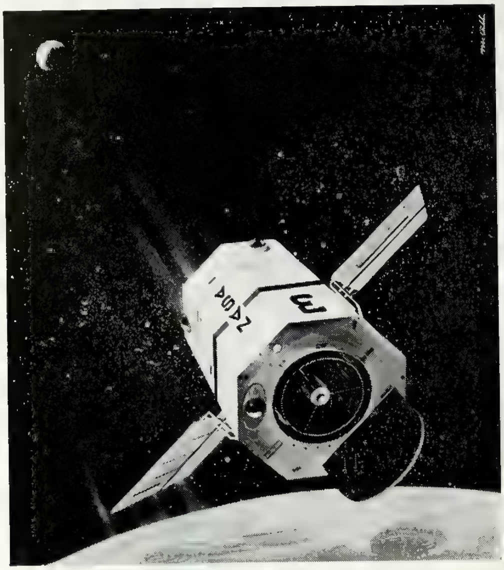
Gemini 8 Awaits Agena Testing

OV's Delivered For Dual Launch

Apollo PCM Units Flight-Qualified

TRW's New Pioneer Nears Launch Date

A telescope hurtling through space "anchored" on a base steadier than Mt. Palomar's?



Astronomical.

Yet true. The 22,000 part control system we developed for the Orbiting Astronomical Observatory (and successfully put through its dry runs) created entirely new design philosophies in satellite stabilization and control.

For a very good reason. To map the celestial sphere in 4 ultra-violet ranges and to accomplish the broadband photometry study of individual stars and nebulae, the 3,600 pound OAO must point its 1,000 pound instrument package with the accuracy and steadiness of earth-bound observatories undisturbed by seismic tremors.

Stiffer design requirements were posed than on any hardware yet launched. An extremely accurate celestially-oriented attitude control system must orient the astronomical telescope at any position in space with accuracies of one-tenth of a second of arc. (In terrestrial terms it's like finding a golf ball 20 miles away and tracking it for 45 minutes from a moving platform.) It will re-orient the main telescope through large angles quickly. And it is required to operate in space for one year with a 94 per cent probability of survival.

What does it all mean? Our staff of engineers, scientists and technicians at Valley Forge are doing some of the most sophisticated thinking around the aerospace industry today.

We're studying possible means for unmanned spacecraft exploration of Mars (Voyager). Recently we were selected as a prime contractor for MOL. And now we've won a contract for the first nuclear power supply to be landed on the moon (SNAP 27). Another Gravity Gradient Stabilization System and another Nimbus will go up next. And our work is backed up by the most advanced, privately-owned space environment simulation facilities in the free world.

Interested?

You are invited to inquire further by writing to: Mr. J. S. Barson, Room 394 M-1 Valley Forge Space Technology Center, General Electric Co., P.O. Box 8555, Philadelphia, Pennsylvania. An equal opportunity employer, M/F.

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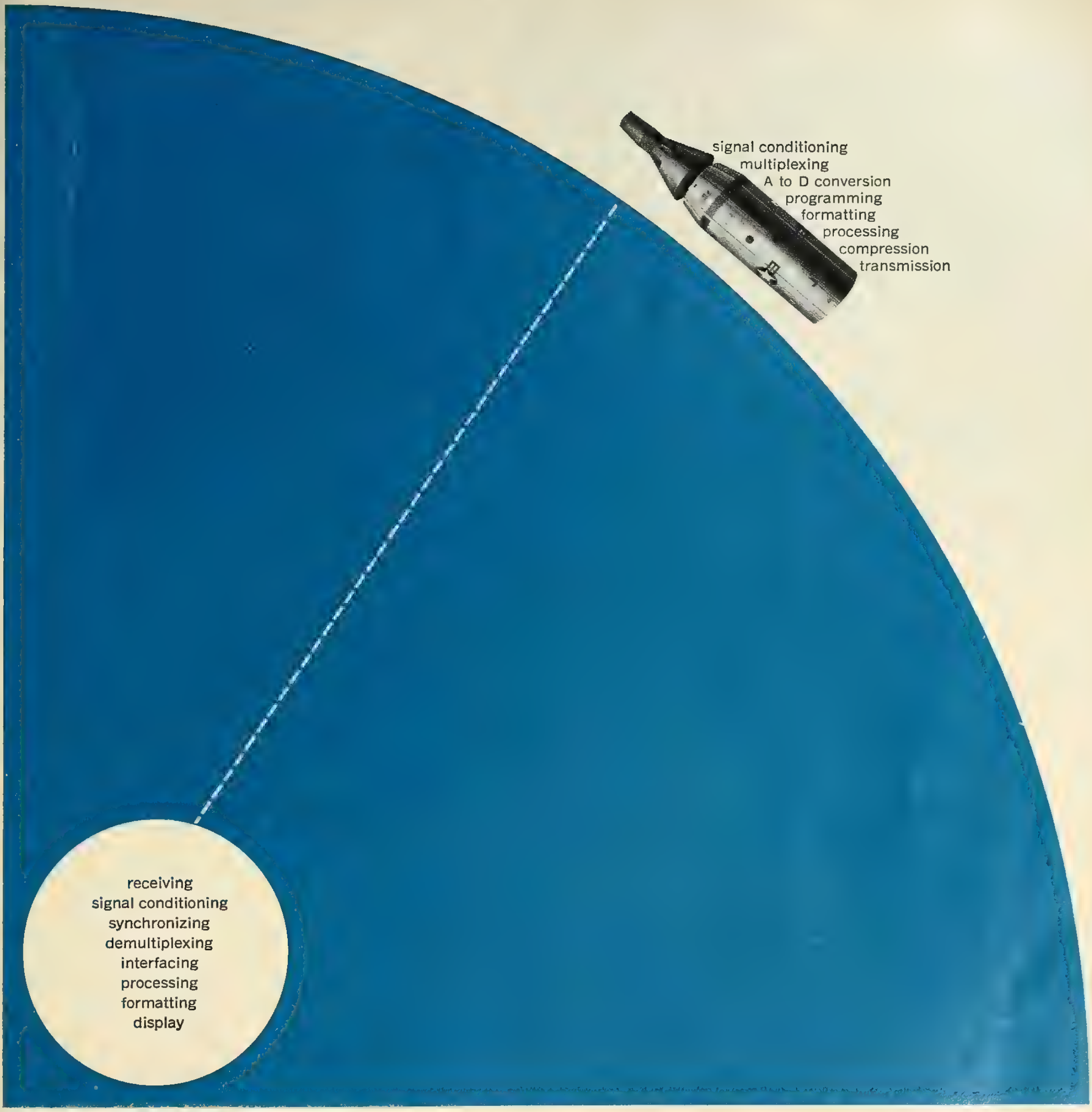

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Vector pioneered in microtelemetry with the world's smallest production-model VCO — only .109 cubic inch, shock tested in excess of 20,000 G's.

Produced by the most advanced microelectronic circuit techniques, Vector components and systems have the high reliability characteristics which can come only from using *true* microcircuit design and production methods.

A family of multiplexers and A to D converters already exists. Vector also has design experience in signal conditioners, processors, synchronizers and demultiplexers. From this firm base, Vector offers complete follow-through — from systems design to hardware production — with the highest possible reliability.

Vector telemetry components and systems are used on a wide variety of space projects, including Saturn, Gemini, and Apollo.

Existing, proved micro-hardware... system design and follow-through capability . . . experience — good reasons why Vector is uniquely qualified to fill MOL requirements for airborne and ground-based data acquisition, handling and processing systems.

Vector DIVISION OF UNITED AIRCRAFT CORPORATION
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Bell System teamwork gets service back fast after Hurricane Betsy–most expensive disaster in our history

In 48 hours of wind-lashed violence, Hurricane Betsy caused untold human suffering and property damage across Florida, Mississippi and Louisiana.

The toll included millions of dollars of destruction to telephone service. More than 528,000 phones were cut off. It was the most expensive natural disaster in telephone history.

The Bell System response was immediate. Supplies and equipment from Western Electric, stockpiled locally in advance of the hurricane season, were broken out for instant use.

Before the storm hit New Orleans, a man was assigned full-time to the Civil Defense Center to help keep its vital communications working. Other Bell System men worked to insure telephone service for the city and the press.

In neighboring Bell Telephone companies, men and trucks were mobilized for emergency duty. Convoys sped south. An airlift was improvised to bring men and material from six states.

Because they were working with familiar, standardized equipment, the out-of-state telephone men were able to go to work as soon as they reached the disaster area.

Within two weeks nearly all the damage from Hurricane Betsy was repaired—poles and cables restored, phones back in service.

And the benefits of a nationwide telephone system with standardized manufacture and operations were proved once again.

C-124 cargo planes of the U.S.A.F. Reserve airlifted men and trucks at Bell System expense to the New Orleans disaster area.

BELL SYSTEM

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American Telephone and Telegraph
and Associated Companies

missiles and rockets

THE WEEKLY OF ADVANCED TECHNOLOGY
Volume 17, Number 23 December 6, 1965

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THE COVER

Sunlight is reflected by Pioneer solar probe during antenna tests at TRW Systems Group's Space Technology Center, Redondo Beach, Calif. The spacecraft, built for NASA, is scheduled to be launched from Cape Kennedy during the week of Dec. 12.

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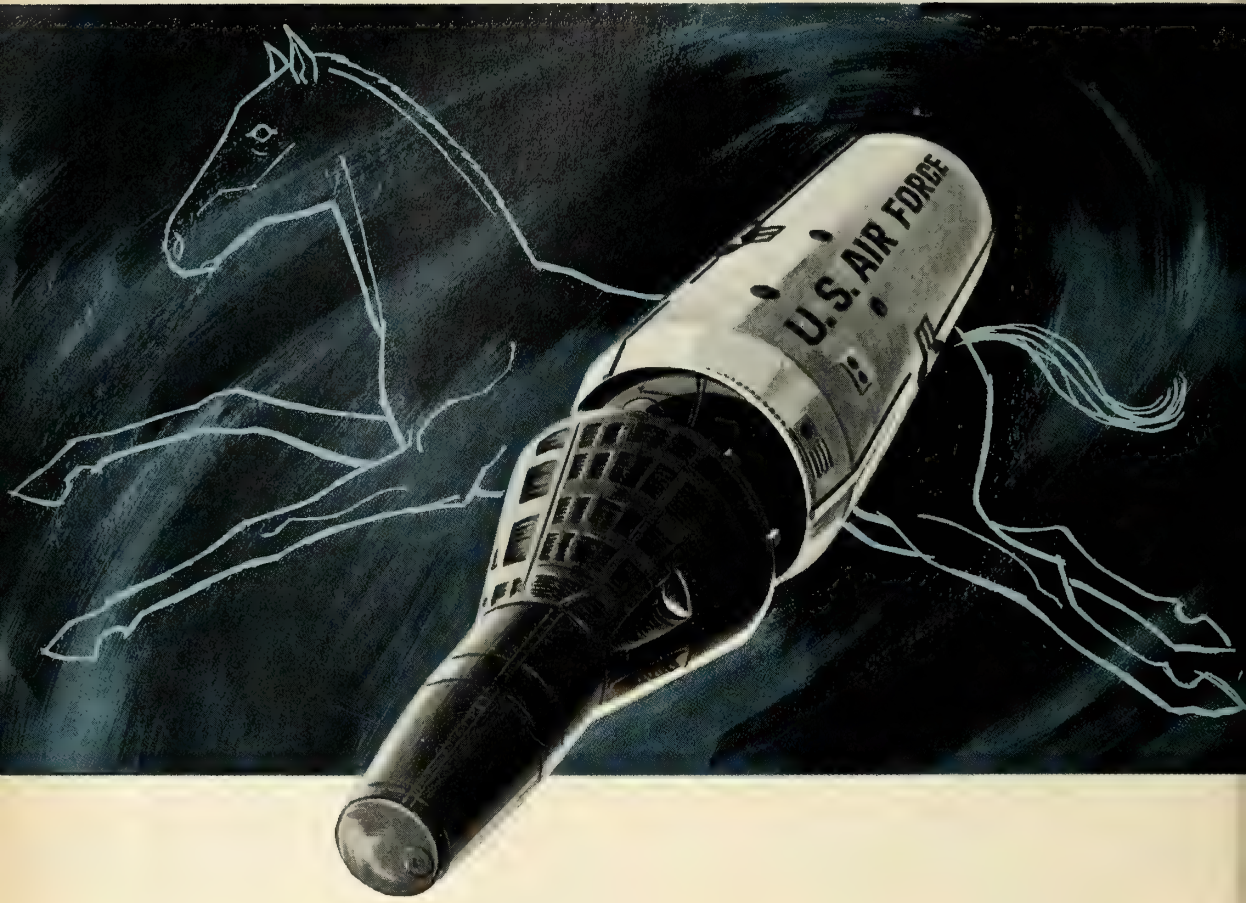
48,500 copies this issue

COLT . . . designed for MOL



EMR has developed **COLT** specifically to meet the telemetry needs of MOL.

COLT is the short way of saying Computerized Orbiting Laboratory Telemeter — a digital data acquisition/processing system which makes spaceborne format flexibility and data compression a reality. It's the next generation of telemetry, but it's in final development **now.**

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R&D & Incentives

To the Editor:

A somewhat confusing report of my talk to the National Security Industrial Association appeared in your Nov. 8 issue ("Incentive Contracts Criticized," p. 10). The confusion stems from interpreting my remarks on the R&D award process as applying to incentive contracting, a subject casually mentioned in my talk.

To clarify, I did criticize the use of incentive contracting in research and development, believing formal incentives more apropriate to production procurement than to R&D. The little evidence we have gathered in studies of 14 R&D incentive contracts ranging from $2 million to $200 million in size shows no significant benefits attributable to the incentive form of contracting but does illustrate a number of drawbacks, as correctly enumerated in your report. For proper perspective, however, these remarks on incentive contracting occupied one minute of a 25-minute speech!

The body of my NSIA presentation dealt with the process underlying the award of R&D contracts under $1 million in size, including both CPIF and CPFF cases. Here our careful studies of over 100 formally-competitive R&D awards issued by DOD installations demonstrate that the required formalities add little to the effectiveness of the awards. In 83% of the cases the awards eventually went to one of the top three bidders recommended by the government technical initiator when he prepared the Procurement Request. An additional 6% went to other firms recommended by the initiator.

Only 11% of the R&D awards went to companies added to the source solicitation list by the procurement office, despite the fact that the procurement office solicited twice as many companies as were recommended by the technical initiator. This 11% of "exceptions" to the normal award process seemed motivated generally by exceptional situations, such as: (1) the switching of technical evaluators between initiation of the procurement and the award; (2) decisions to no-bid by one or two preferred solicited firms; (3) large, often unrealistic dollar gaps in bids received on these cost-plus jobs, resulting in pressures to make awards to the low bidders; (4) broad industry-wide solicitation aimed at generating ideas for development of a long-term government research program. Thus these "exceptions" seem not to justify the huge waste of time, talent and money caused by the 6-8 months of formal proposal solicitation, preparation and evaluation.

In the concluding portion of my NSIA talk I suggested five types of changes that should improve procurement effectiveness of R&D jobs less than $1 million in size. The changes recommended are: (1) enhanced flexibility and power for the government technical initiator to choose alternate simplified means of soliciting information to aid his source selection; (2) elimination of deceptive practices by some government agencies; (3) changes in cost allowances to discourage "blind" bidding practices; (4) increased strengthening of formal and informal channels of technical communication between government and industry; and (5) enlargement of job status of government project initiators and monitors, with increased rewards accompanying increased responsibilities and performance.

Edward B. Roberts
Associate Professor of Management
Massachusetts Institute of Technology
Cambridge, Mass.

New Unit of Velocity

To the Editor:

Since we are now well launched into the space age and in a very short time an increasing number of ordinary vehicles will be able to fly above the atmosphere as well as in it, it appears to this writer that the units curently used to describe speed are beginning to lose their meaning. For example, the Mach number can have no meaning in free space, where there is no medium to transmit sound. On the other hand, current orbital and space-vehicle velocities have meaning to relatively few. All speeds do, however, have a relationship to the ultimate in speed, that of light in a vacuum. It would therefore seem that consideration (should) be given to a practical unit which I have designated as the micro C (μC), C being the velocity of light. Using this unit, two currently used velocities, Mach 1 and orbital velocity, become more simply related. Taking C as 186,272 miles per second (Binge), the miles per hour equivalent is 670.58 x 10^8. Taking Mach 1 at the appropriate altitude as 670.58 mph, this speed becomes 1 μC. On the other hand, taking an oribtal velocity of 7 miles per second, the μC figure becomes 37.58.

Because each nation employs its own unit of measurement, the term C carries along with it the appropriate units. For this reason the designation of velocity in terms of C may have lasting practical international value.

L. A. Geddes, M.E., Ph.D.
Chief, Section of Biomedical Engineering
Professor of Physiology
College of Medicine
Baylor University
Houston, Tex.

The California Experiment

To the Editor:

I concur with your description of the qualifications of M/R's West Coast bureau chief, Willard E. Wilks, in the systems analysis field (Editorial, "The Next Step," M/R, Nov. 15, p. 46). He has summed up the main points of the Nelson hearings very well.

Donald Ramsay
Head of Public Information
Corporate Communications
System Development Corp.
Santa Monica, Calif.

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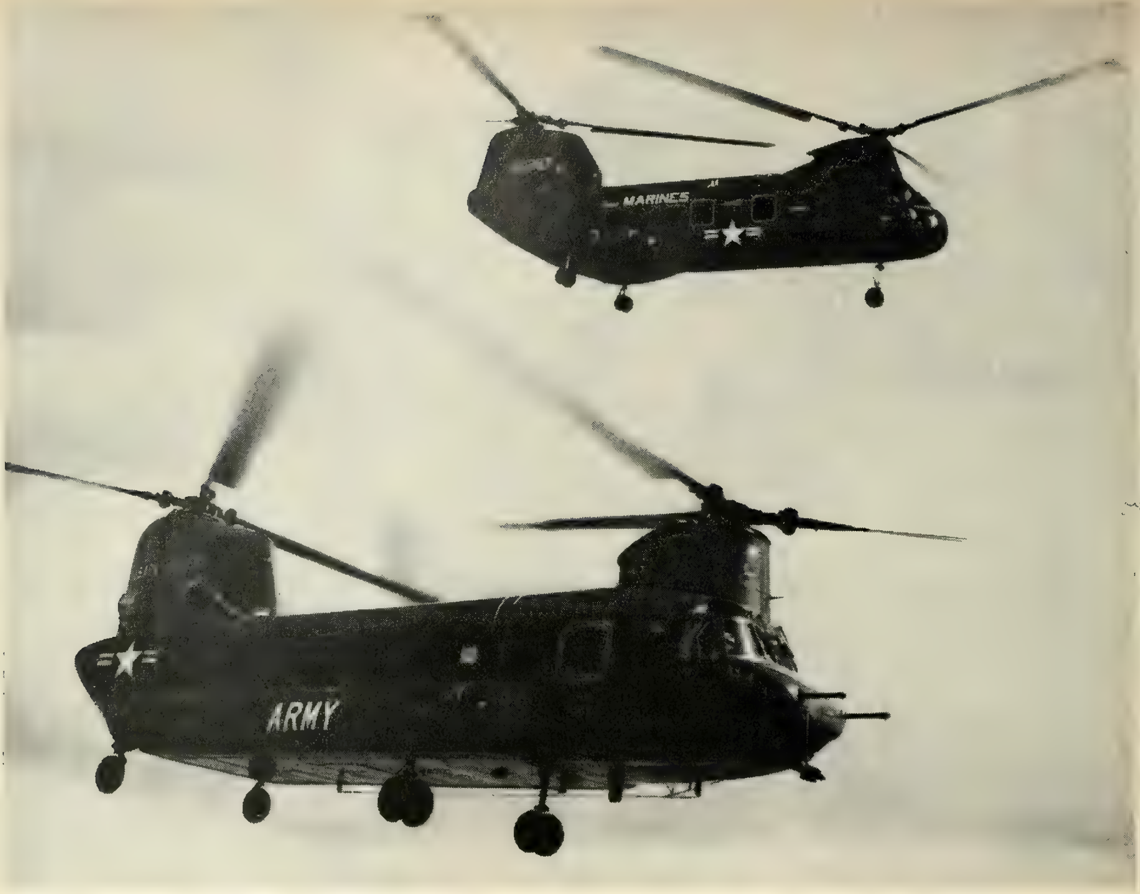
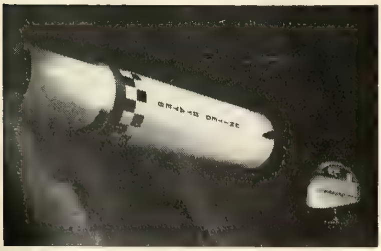
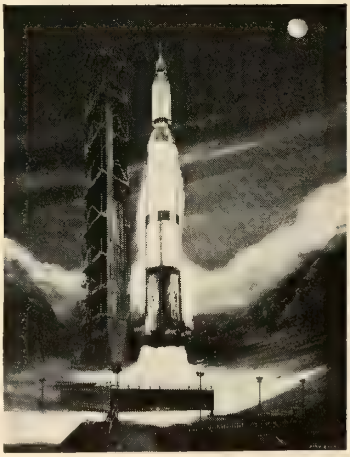


TWIN TURBINE Boeing/Vertol helicopters now serve with U.S. Army, Marine Corps and Navy. Sea Knight assault helicopter (at top above) can carry up to 25 fully-equipped combat troops in "vertical envelopment" and other prime missions. It's operational with Atlantic and Pacific Fleet Marine Forces. The U.S. Army's Boeing/Vertol Chinook (pictured with Sea Knight above) has been deployed to Viet Nam with the 1st Cavalry Division (Airmobile). Each Chinook can deliver a complete infantry platoon, or a complete artillery section, to assault landing sites. Chinook is U.S. Army's standard medium assault helicopter.

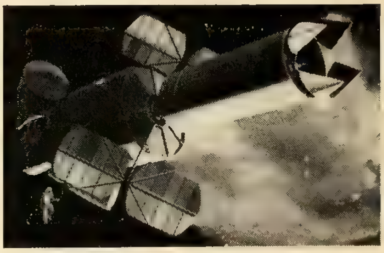
Capability has many faces at Boeing



SPACE maneuvers, such as rendezvous and docking, are simulated in Boeing Space Center. Pilots "fly" spacecraft, controlled through computers, in simulated trajectories, velocities and approach angles of space docking missions.



WORLD'S largest rocket, NASA's Saturn V, will launch first Americans to moon. Boeing holds NASA contract for S-1C booster, developing thrust equivalent to 160 million horsepower.



ORBITING EYE, a manned telescope to orbit earth 200 miles high, is subject of a Boeing study for NASA. Space telescope could penetrate 20 billion light years, compared to today's three. The Boeing study involves integrating orbital telescope with a manned space station.

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The Countdown

WASHINGTON

Larsen Taking Over as Deputy of DDR&E

Dept. of Defense was expected to announce late last week appointment of Dr. Finn J. Larsen as Deputy Director of Defense Research and Engineering. A former assistant secretary of the Army for R&D, Larsen will fill a post vacant since July 15, when the former DDR&E deputy, Dr. Eugene Fubini, left to take a post with IBM. Larsen, however, will not have an Assistant Secretary of Defense title, as did Fubini. Last remaining AsstSecDef position was given to Alain C. Enthoven in July, with the creation of a new Office of Systems Analysis within the top echelon of DOD. Larsen comes to the Pentagon from his post as a corporate vice president of Honeywell, Inc., where he headed the firm's newly created Systems and Research Div.

Martin Reported Winner of Walleye Contract

Sources close to the Navy's *Walleye* development program report that Martin Co.'s Orlando Div. has won the competition for production of the TV-guided glide bomb. Contract, however, may not be announced for about three weeks. *Walleye* is expected to be produced in very large quantities for the Navy and will also be bought by the Air Force (see related story on p. 14). In addition to Martin-Orlando, North American Aviation and Hughes Aircraft held definition-phase contracts.

California Rains Defer M-2 Flights

First flights of the M-2 lifting-body vehicle are now off until January. The captive flights—during which the vehicle will be strapped to its B-52 mother plane—were scheduled for November, but heavy rains in the California dry lakes landing area forced postponement. Since a pilot will be inside the M-2 during even the captive flights, officials feared that the wet lakes might be a problem in an emergency landing.

NASA Lying Low until January

Administrator James E. Webb has informed NASA officials that he does not want any new programs initiated until next month. His reason is that he doesn't want any publicity about new programs until the FY '67 budget is given final approval by the Johnson Administration. This probably will delay North American's second-phase contract on modifications to extend the lifetime of the *Apollo* spacecraft and feasibility studies of the entire *Apollo* Applications program.

Assembled NERVA Due for Early Firing

First test of a breadboard NERVA nuclear engine is now scheduled for sometime between Dec. 22 and early January. It will mark the first time all components of the engine, including its reactor, are tested simultaneously.

First Saturn-Apollo Shot in Mid-January

Jan. 17 has been set for the first in a series of *Saturn-Apollo* missions to be launched from Cape Kennedy. The unmanned SA-201 flight is designed to qualify the Command Module heat shield under a super-heating re-entry. The Command and Service Modules will be lofted by a *Saturn IB* on a ballistic trajectory with predicted impact about 4,000 n.mi. downrange, near Ascension Island. Re-entry velocity of 27,000 fps will be achieved by burning the Service Module engine for approximately 200 sec. to ram the re-entry vehicle back through the atmosphere.

Gemini Maneuvering Gun Jams

Problems crept into qualification of *Gemini 8* extra-vehicular equipment at Manned Spacecraft Center last week during low-temperature (—300° F) tests. The maneuvering gun—a refinement of the *Gemini 4* device—"froze up" after 27 firings, although it is designed for a 40-start capability, MSC says. The EVA support pack, with an oxygen supply for the astronaut and a Freon supply for his gun, ran into valving troubles. Both units were built by MSC in-house.

Aerojet To Build Liquid-Fueled Torpedoes

Navy has awarded Aerojet-General Corp. an additional $2 million to provide a number of new Mod 1 Mk 46 torpedoes using liquid propulsion instead of the solid system aboard the earlier Mod 0 version. In August, Aerojet received $62 million for production of the Mod 0, and first operational units were delivered last month. Mod 1 will also use electric steering, rather than the hydraulic system employed in Mod 0.

Air Force Seeking New Penetration Aids

Air Force's Ballistic Systems Div. is expected to issue RFP's, probably around Dec. 23, for development of endo-atmospheric decoys for use as ICBM penetration aids. Some 45 organizations are expected to receive requests.

INDUSTRY

Reports on 'California Experiment' Available

State of California has made available at cost copies of final reports by missile/space firms that have performed state-contracted studies of California problems. Three of the four reports are already available—Information-Handling (Lockheed, $5.72), Prevention and Control of Crime and Delinquency (Space-General, $4.94); and Waste Management (Aerojet-General, $8.32). Copies may be ordered from: Documents & Publications Section, Office of Procurement, State of California, 517 Eye Street, Sacramento, Calif.

Telecomputing To Service GSFC

Telecomputing Services, Inc., a subsidiary of Whittaker Corp., has signed a two-year, $4.4-million NASA contract to provide on-site data-reduction and computing services at Goddard Space Flight Center. An option may add another $2.6 million.

INTERNATIONAL

First Test of French Stage of ELDO Launcher

LRBA (Laboratoire de Recherches Balistiques et Aérodynamiques) has reported that the first full-scale testing of a Coralie engine took place at Vernon on Oct. 29, 15 days ahead of schedule. Firing of the engine, second stage of the European Launcher Development Organization's *Europa* booster, lasted 96 sec. Compatibility of the four-nozzle liquid engine with the flight-type structure was checked out, and the low level of vibration was called highly encouraging. A second test is due soon.

ABM Moratorium Questioned

U. S. defense officials say they see nothing new in the arguments put forward by the National Citizens' Commission Committee on Arms Control and Disarmament calling for a three-year moratorium on deployment of an anti-ballistic missile (ABM) defense system.

The arguments were presented at the Nov. 28-Dec. 1 White House Conference on International Cooperation in Washington. Another story on the conference appears on page 15.

Defense officials feel that all the considerations involved in the question of ABM systems mentioned in the report have been taken into account by the Defense Dept. and that no new evidence that could alter the DOD position has been presented.

Dr. Jerome B. Wiesner, former Presidential science advisor, headed the committee at the conference. He told MISSILES AND ROCKETS that he had no indication as to how the committee's recommendations were received by President Johnson, although he did express doubt that the decision to deploy the *Nike-X* ABM system had already been made. Wiesner is dean of the Massachusetts Institute of Technology School of Science.

In making its case for a moratorium, the committee struck most heavily at what it considers to be the insufficient thought the U.S. has given to the political consequence of an ABM deployment, in particular the possible unintended effect of the system on the Soviet deterrent force.

The committee raised the following questions they consider to be "unanswered and unconsidered": Shall the systems be placed in Europe? Will they be sold to allies by the U.S. or by the Soviets? Can this nation and the Soviets acquiesce in reduced, but still enormous, deterrent capabilities? Will U.S. action simply play into the hands of the Communist Chinese effort to disrupt U.S.-Soviet relations in general and arms limitations efforts in particular? Does the Chinese threat require immediate action on the part of the U.S. and the Soviets? How far are the U.S. and the Soviets planning to go in building active defenses?

Second Diamant To Carry D-1

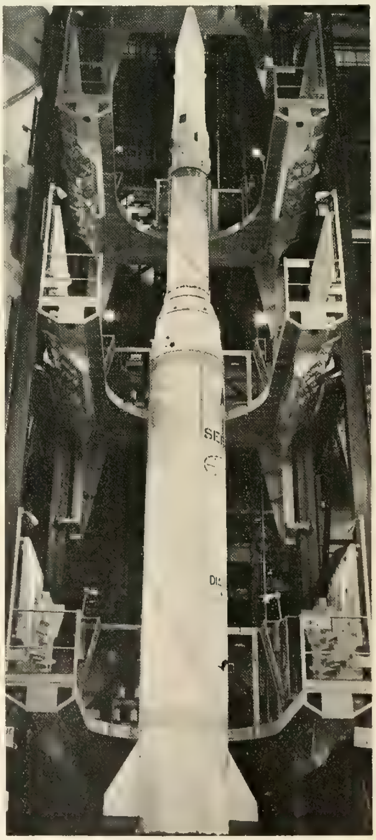
Second full-scale launching of France's *Diamant* space booster vehicle is tentatively scheduled for next month to orbit the *D-1* satellite.

The first launch from the Hammaguir range in Algeria on Nov. 26 was described as "perfect" by French officials even though the *A-1* satellite slightly missed its orbit. Originally planned to circle the Earth with an apogee of 1,850 mi. and a perigee of 330 mi., the 88-lb. test satellite achieved an 1,110-mi. apogee and 315-mi. perigee.

The *A-1* has a planned, battery-powered lifetime of 15 days and is primarily designed to check out the launch of the *Diamant*. The satellite will furnish only trajectory and temperature data.

Meantime, the French *FR-1* satellite was due to be launched atop a NASA *Scout* booster from Vandenberg AFB, Calif., on Dec. 6. A success, followed by the January launch of *D-1*, would quickly put France in third place among nations with orbiting satellites.

D-1 is the first of a series of payloads again designed to check out the *Diamant* system together with the French network of tracking stations and the on-board equipment completely supplied by French firms.



Diamant used to launch A-1 satellite.

The *D-1* satellite will also be used by CNES scientists to study methods of orbit determination by interferometry and Doppler-effect measurements.

D-1 will have an expected lifetime of some 90 days in a spin-stabilized, 120-min. elliptical orbit. The 41-lb. satellite will carry three onboard transmitters—136 mc, 250 mw and PFM with 30 channels for telemetry and tracking.

All three stages of the *Diamant* launch vehicle evolved from other test programs in a planned building-block approach. The *Emeraude* program developed the liquid first stage, which is rated at 233 sec. Isp. The propellants are nitric acid and essence of turpentine.

Second stage is a modified *Topaz* IRBM research vehicle using a solid propellant. The third stage evolved from the second stage of the *Rubis* rocket system using a solid propellant. All three stages have been fired in other research programs.

The Nov. 25 launch marked the first flight of the *Diamant*, the first separation of second and third stages, and the orbiting of the third stage. The *Diamant* system is under technical management of SEREB and the responsible agency is CNES, with the Délégation Ministerielle de l'Armament.

Last Apollo Abort Set

The last flight in the *Little Joe-Apollo* abort series is scheduled for Dec. 8.

The sub-orbital mission from the White Sands Missile Range, N.M., will test *Apollo's* launch escape subsystem by simulating a power-on tumbling abort during the launch phase of a manned *Apollo* flight.

In the test, the *Apollo* spacecraft —consisting of Command and Service Modules and the launch escape subsystem—will power itself away from the launch vehicle and will return to Earth by parachutes.

Little Joe II is produced for NASA by the Convair Div. of General Dynamics Corp.

For the test, *Little Joe II* will use only a portion of its rated thrust capability. It will be powered by four Algol solid propellant motors, built by Aerojet-General Corp., each delivering an average vacuum thrust of 108,500 lbs., and five Recruit solid propellant booster motors, built by Thiokol Chemical Corp., each delivering 37,500-lbs. thrust for 1.5 seconds.

Little Joe II will carry 15,000 lbs. of steel plates as extra ballast to keep its power within mission requirements. The booster will be launched at an 84-degree angle, then initiate a pitch-up maneuver causing a "tilt" and signaling abort condition.

During some 80 seconds of powered flight, *Little Joe II* will drive the *Apollo* spacecraft to an altitude of about 62,000 ft., and to a velocity of about 1,600 miles per hour.

Then the launch escape subsystem will propel the spacecraft away from the launch vehicle and power it to a peak altitude of about 73,000 ft.

The *Apollo* module will return to Earth by parachutes about 6½ minutes (390 seconds) after liftoff and about 20 mi. uprange from the launching site.

Shots of the Week

Simultaneous launch of the U.S. *Direct Measurement Explorer (Explorer XXXI)* and the Canadian *Alouette II* satellites was accomplished Nov. 28 from the Western Test Range. A *Thor-Agena B* boosted the two payloads into an orbit with a 1,837-mi. apogee, 329-mi. perigee and an inclination of 80 degrees. The launch was part of the NASA-Canadian International Satellites for Ionospheric Studies (ISIS) program.

- France's *A-1* satellite was launched by the *Diamant* booster from Hammaguir range in Algeria Nov. 26. (See article on page 10 for further details.)
- A Strategic Air Command missile combat crew successfully launched a *Titan II* ICBM from Vandenberg AFB, Calif., Nov. 30. The missile impacted in a pre-selected target area in the Pacific Ocean.
- An *Atlas* ICBM was launched from the Western Test Range, the Air Force announced Nov. 29. The shot was in support of the *Nike-X* program. No details were released.
- A British *Black Knight* research rocket was successfully fired from Woomera, Australia, Nov. 25. The rocket reached an altitude of 390 mi. before re-entering the Earth's atmosphere at 10,800 mph.
- The Soviet Union fired two scientific satellites, *Cosmos 97* and *98*, Nov. 26 and 27, respectively. Equipment of both spacecraft was said to be functioning normally.
- The USSR has successfully carried out a series of carrier rocket launches into the Pacific Ocean, Tass has announced. The spacecraft impacted into a circular area with a radius of 40 n. mi. and a center of 35

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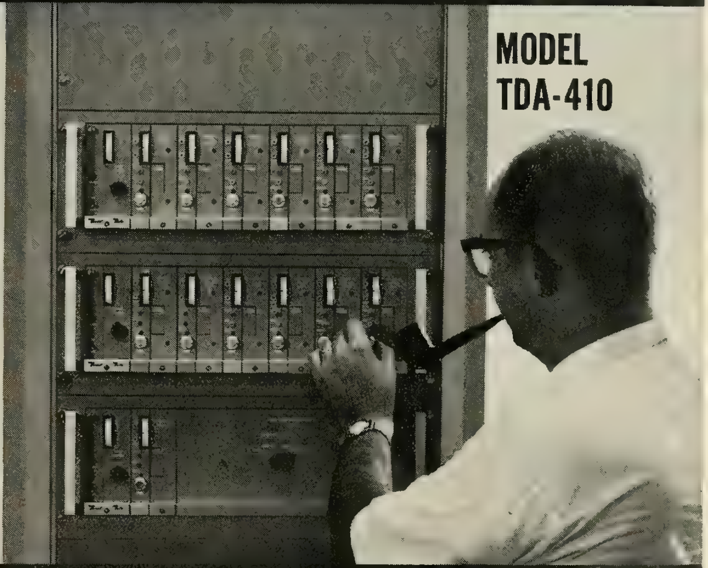

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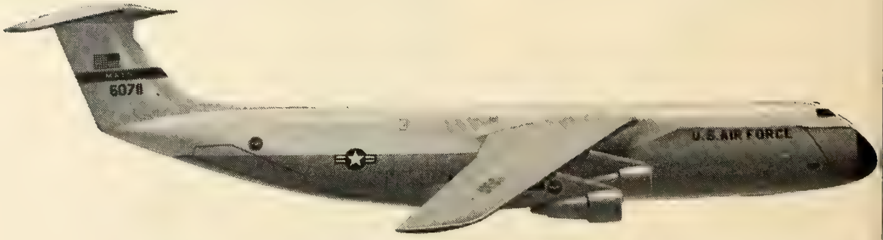

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degrees, 5 min. north and 175 degrees, 43 min. east. No details on the number and dates of launches were given.

J-2 Engine Contract Increased

NASA has increased the value of North American Aviation, Inc.'s Rocketdyne Div. contract for the J-2 engine by $75.8 million for a new total of $206 million.

The add-on provides for 48 more engines to be produced, raising the total purchase to 103 engines. The amendment also calls for the firm to provide such support services as field engineering, documentation and ground test support equipment.

DOD Issues New Cost Guide

The Dept. of Defense was expected to begin distribution late last week of a revised version of its Cost and Economic Information System (CEIS) program to some 2,000 defense contractors.

The new version of the document, which outlines the DOD's intended format for industry cost reporting, was reviewed in recent weeks by a special Aerospace Industries Association (AIA) committee working through the Council of Defense and Space Contractor Associations.

CEIS was subjected to some rather harsh criticism during this review. The recommendations sent to the office of Assistant Secretary of Defense (Comptroller) Robert N. Anthony by the AIA group apparently made sense to DOD, however, since the new document is said to reflect many of the recommended changes. A major AIA point was that the original plan had requirements for excessive amounts of data.

What makes industry observers even happier has been the relationship with Anthony's office over the proceedings to date, especially the fact that CEIS was not presented to the industry as a *fait accompli.* Contractors are expected to have 60 days to review the new version and a target date of March 1 has been set for putting it into effect.

Congress To Probe R&D

A Congressional subcommittee plans to hold hearings dealing with such questions as whether the *Apollo* lunar landing deadline could be put back until 1975 to free R&D money for social and economic projects.

The new subcommittee on research and technical programs of the House Committee on Government Operations is chaired by Rep. Henry Reuss (D-Wis.). It will look into one basic question: "Do we possess efficient machinery for determining that our scientific resources are economically employed to achieve our vital national goals?"

In a statement announcing the hearings, Reuss said that "decisions on R&D expenditures are made in an unsystematic manner, not properly considering all the national goals." He cited the lack of spending on application of science and technology to such social problems as waste management and public housing.

Postponement of the *Apollo* goal, he suggested, would free "approximately $1.5 billion a year—without increasing Federal outlays—for R&D into such problems as housing construction, urban transportation, and pollution control and abatement."

Reuss added that while allocating R&D resources among competing national goals presents difficult decisions, government agencies could simplify the problem by ranking items in their research budgets on a priority basis. Tradeoffs could then be made among the lower-ranking items, with a view to eliminating research projects with the lowest cost-benefit ratio.

NMC Given New Task

The Naval Missile Center, Point Mugu, Calif., has been given engineering cognizance of operational air-launched weapons for the Bureau of Naval Weapons.

The move is part of the bureau's effort to decentralize its functions. An in-service engineering office has been established within the center's laboratory department to carry out the new responsibility. It is headed by H. W. Howard and will receive approximately $300,000 in funding during the first year.

Management Guide Available

A two-volume guide for firms having or desiring research contracts with the Navy is now available. Copies of the "Dept. of the Navy RDT&E Management Guide" can be obtained by writing the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

Also available there is the "Guide for the Preparation of Technical Development Plans" of the Office of Navy Material.

AF Seeks New Tactical Missile

DOD approval to be asked for air-to-surface weapon dubbed Maverick; program value could be greater than $100 million

by Michael Getler

THE AIR FORCE will ask for Department of Defense approval to initiate development of a new tactical air-to-surface missile system, the AGM-65A *"Maverick."* The program has a potential value in excess of $100 million, project sources told MISSILES AND ROCKETS.

Concept for the weapon has been developed within the Aeronautical Systems Division's Tactical Missile Program Office at Wright-Patterson AFB, Ohio, and has reportedly been approved by Air Force Systems Command.

Sources close to the project say they are optimistic about the program's chances within DOD and have set a tentative target date in mid-February for issuance of requests for proposals to industry for project-definition phase contracts. It is also planned to initiate production of the missile, pending DOD approval and a successful PDP, about a year after the definition phase begins, project sources report. There is also the possibility that some long-leadtime items associated with the missile system will be put into development before then.

- **Assist from Vietnam**—The war in Vietnam has provided a considerable sense of urgency to the overall Air Force effort in development of new and more suitable tactical missiles, and *Maverick* appears to be one of the earliest benefactors. The missile is one of several new designs that have been under intensive study within the Air Force and some major new action on its future had been predicted (M/R, Oct. 18, p. 21).

Maverick is to be a TV-guided missile designed to be launched from a variety of Tactical Air Command aircraft, including the McDonnell F-4C, the Northrop F-5, and the Republic F-105. Its use aboard earlier aircraft in the Air Force Century series fighter/attack aircraft is also a possibility.

Development of effective electro-optically guided missile systems has been a long-sought-after goal of both the Navy and Air Force (M/R, Oct. 18, p. 21) but its evolution, although proved feasible more than a decade ago, has only recently received the necessary impetus for hardware development—a direct result of lessons being learned and aircraft losses in Vietnam.

Major activity in this field thus far has taken place in the Navy's efforts to develop the *Walleye* TV-guided glide bomb. *Maverick* will mark the first large Air Force program in this area, but will also draw heavily upon Navy experience with *Walleye*. *Maverick* project officers point out that *Walleye* has already demonstrated a very high accuracy and low CEP (Circular Error Probability), and that no matter what type of electro-optical seeker is investigated, it generally centers upon the technology first probed for *Walleye*.

Although the *Maverick* seeker will include some refinements as a result of its newness, project sources say it is not yet clear whether a CEP better than that demonstrated by *Walleye* will be necessary.

- **Eglin results favorable**—The major input to the *Maverick* development has been the flight-test program carried on by the Air Force at the Eglin, Fla., Air Proving Ground Center using the *Hornet* missile as a vehicle for a demonstration TV-guidance system developed by North American Aviation, Inc. Project sources say all indications are that this seeker can be used under proper conditions, namely when the pilot can see the target.

The lack of all-weather or night capability is apparently one of the major drawbacks with TV systems, although this limitation is shared with some other concepts. But the TV technique offers many advantages.

Tactical missile experts expect the missile will allow weapons delivery from a greater stand-off range, with greater accuracy, and with greater safety for the pilot than current systems such as the radio-command guidance *Bullpup* missile. TV-guidance systems reportedly do not require the pilots to monitor the flight in the cockpit and to fly down the target vector while the missile is en route to the target.

- **Compared to Walleye**—Effective range of the *Maverick* is said to be in the same category as *Walleye*, but *Maverick* reportedly will carry a smaller warhead than does the Navy weapon. Since the Air Force is also expected to buy *Walleye* for use on its aircraft, the two systems are seen as giving the Tactical Air Command an option of weapons to use against different targets.

Although *Walleye*, which is believed to weigh between 500 and 1,000 lbs., does not have any propulsion system, it is not yet decided, project sources say, whether the *Maverick* system will use the same glide approach or will have a rocket propulsion unit. Informants say only that the Air Force has definite views on this matter and has made recommendations.

Because of the large potential size of the *Maverick* program and the likelihood that some new test facilities may be required, a briefing on the early development plans for the missile was held last month at Eglin involving personnel from ASD and four key Eglin agencies—the Air Proving Ground Center, Director of Armament Development, Tactical Air Warfare Center and the Special Air Warfare Center. ■

Army Has Lightweight 2.75 Rocket Launcher

A NEW launcher for the 2.75-in. rocket will go into the field early next year aboard helicopters, the Army has announced. The XM-158 is a lightweight reusable pod made up of seven tubes. It was developed by the U. S. Army Missile Command and successfully tested at Redstone Arsenal.

Greater Joint Space Effort Endorsed

But report by National Citizens' Commission to White House international cooperation meeting offers no major new proposals

by William S. Beller

A NATIONAL CITIZENS' Commission report on space, prepared for President Lyndon B. Johnson, calls for "rapid growth of space activity abroad" but outlines no major new international projects to accomplish this.

This report was one of 30, each dealing with a different aspect of international cooperation, presented in Washington, D.C., Nov. 28-Dec. 1 to more than 2,000 registrants at the White House Conference on International Cooperation.

The conference was called by the President to "search and explore and canvass and thoroughly discuss every conceivable approach and avenue of cooperation that could lead to peace," as part of the International Cooperation Year, designated 1965.

Reports were classed by each session chairman as "draft and nongovernment." But they were written in close consultation with government officials, according to a White House release.

In format, the gathering most closely resembled a giant stockholders' meeting, with officers and board of directors drawn from the nation's top scientists, communicators and educators, and audience from the most articulate but not necessarily coherent citizenry.

● **Space**—Highly generalized avenues for international cooperation marked much of the space discussions. This was not unexpected, since recognized space experts framed the report along recognized lines.

The Lunar International Laboratory (LIL), proposed by the International Astronautics Federation for the past several years as a feasible joint project for many nations, was not mentioned; nor were any other long-ranging specific international projects. However, there was room in the report to turn to the possibility of using communications satellites to help physicians get the knowledge "to conquer heart disease, cancer and stroke and related diseases . . ." Unlike most of the other committee reports, this one had no "recommendations" but substituted some "possibilities" for the future.

Several concrete suggestions were, nevertheless, made by Vice President Hubert Humphrey in his keynote speech to the space session. Noting that the United States has to learn about international cooperation and create the environment for it, he suggested that NATO seek "new areas of common and peaceful effort—areas appropriate to a changing world situation." He said that "certainly, cooperative, peaceful projects in space should be of high priority" in this effort.

Departing from his prepared text, the Vice President alluded to the Soviet Union's threat of orbiting a nuclear weapon and commented, "The United States is committed to the terms of the (United Nations') resolution prohibiting weapons of mass destruction in space" and it behooves other countries to conform to this resolution. He added, pointedly, "We want outer space to be a laboratory for man's progress—not a battleground for man's destruction."

● **MOL undefended**—In this context, a member of the audience asked the panel why the United States is pursuing the *Manned Orbiting Laboratory* as a military project and suggested for the "sake of peace" that space laboratories might better be in the hands of an agency such as NASA. Questions from other audience participants indicated that they saw no difference between *MOL* and an orbiting nuclear weapon.

Curiously, the space panel did not volunteer a defense of *MOL*, failing even to point out that *MOL* is not a bomb, or that the Soviet space program is one of that nation's biggest military projects.

In his talk, the Vice President stressed the need "for increasing interchange of technical documents and information between governments, universities and centers of research in developed and developing countries alike."

Humphrey objected to the prospect that obsolete equipment used in space research and development might be relegated to the Smithsonian Institution or "the courtyard of the Museum of Modern Art." Such equipment, particularly banks of computers, would be "prized" outside the United States, and should be made available, he declared.

● **For future reference**—Although the space meeting was dominated by long, nostalgic looks backward and short, timid looks ahead, several "ideas which may deserve further study and investigation" were described in the formal report:

—*New satellite launch sites.* Advantages could come from locating a site at the equator, for instance, to take maximum advantage of the Earth's rotation; for a synchronous orbit, such a launch site would be ideal. Other geographic positions conceivably would have their own unique advantages.

—*Multipurpose navigation satellite systems.* They would be used for marine and air navigation, traffic control, distress calls, and assistance in rescue operations. Clearly, a global navigation satellite system is feasible, as evidenced by the Navy's *Transit* program.

—*Experimental data-gathering satellite system.* This system "would collect information from such sensing devices as buoys, meteorological ground stations and constant-altitude balloons."

—*Synoptic sounding rocket investigations.* The idea is to get synoptic looks at the Earth's atmosphere. To do this, scientists need launch sites at all meteorologically strategic locations on Earth, including the equator, auroral zones, and intermediate latitudes.

—*Applications of communications satellites.* This category includes using satellites as communications links between international offices of major companies, computers thousands of miles apart, ground stations and aircraft, and broadcasting stations.

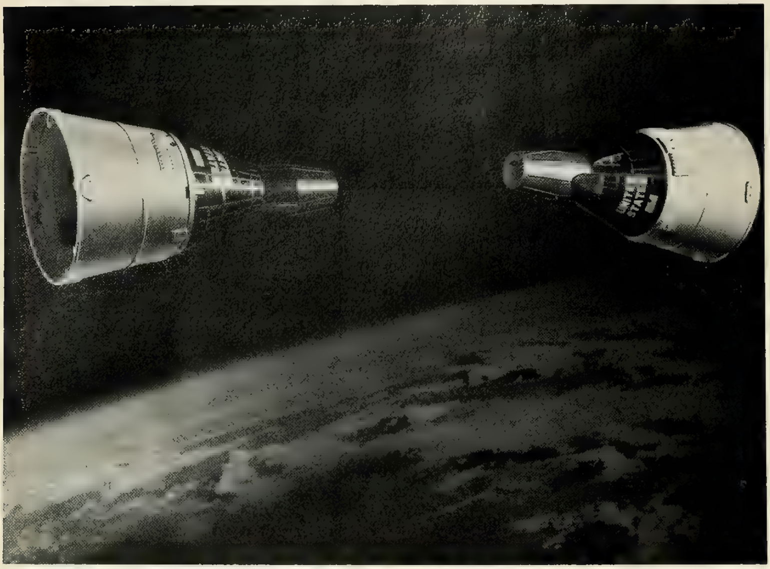
The "most revolutionary change" promised by communications satellites within the next decade would be direct broadcasting from satellites into the home receiver. Noting this conclusion of the Citizen's Space Committee, Joseph V. Charyk, Communications Satellite Corp. president, said, "capability can be demonstrated from the technological point of view." But he saw a long road ahead before direct broadcasting became practical.

● **Atoms for Peace**—"How are we going to keep the fissionable material given (for peaceful purposes) from being turned to bombs?" asked Dr. I. I. Rabi, Nobel-prize winning physicist and professor of physicis at Columbia University. Speaking as a member of the Citizens' Committee on Peaceful Uses of Atomic Energy, Rabi said preventing diversion of atomic materials is one of the most difficult problems in designating atoms for peace. He said safeguards entail some loss of sovereignty of nations permitting inspection of their atomic installations, additional expense in the design of the reactors to permit easy inspection, and a consequent loss in the reactors' efficiency. ■

Agena Tests Key to April Gemini Shot

NASA decides on shorter period of reverification testing but won't begin until February; Gemini 6 seen having improved rendezvous chance

by Jinx Mercer



APPROXIMATE POSITIONS of Gemini 7 and 6 as they are to be at the end of the proposed rendezvous. Gemini 6 is to be launched nine days after Gemini 7.

THE SPACE AGENCY has announced that a series of reverification tests on the *Agena* target vehicle will begin in February in an attempt to get the *Gemini 8* mission off the pad by April.

The announcement was made as NASA continued last week with plans to launch the *Gemini 7* spacecraft with astronauts Frank Borman and James Lovell at the controls on Dec. 4 for a 14-day stay in space. If all goes well the *Gemini 6* spacecraft will be launched nine days later in the first U.S. attempt to rendezvous two manned vehicles in orbit.

The test series on the *Agena* target vehicle—ordered following the *Agena* failure during the *Gemini 6* mission on Oct. 25—will last from two to three weeks or for an undetermined length of time, the space agency said.

Earlier it had been learned that the Air Force, which developed the target vehicle, wanted four months of testing, but NASA believed only two months would be required (M/R, Nov. 22, p. 13). It appears that NASA now believes an even shorter period of time will suffice.

An *Agena* will be moved into the Air Force's large vacuum chamber at Tullahoma, Tenn., where it will undergo repeated main engine start at a simulated altitude of 150,000 ft. under various temperatures and simulated failure modes.

● **Back to normalcy**—Modification to the vehicle following the *Agena 6* failure consists of reverting the fuel-oxidizer injection-lead pattern to that existing in standard *Agena* configurations.

This pattern was reversed on the *Agena 6* vehicle to permit a fuel injection lead into the thrust chamber to conserve propellant. NASA requires a minimum of 15 engine restarts in orbit and fuel conservation was deemed necessary to achieve this.

MSC said the late starting date for the test reflects the time required to pull down a Lunar Excursion Module ascent stage engine and its supporting rig, presently undergoing tests inside the Tullahoma chamber.

Earlier, the Air Force had been reported anxious to start the tests late this year.

● **Out of 1st quarter**—By putting off the tests until February, NASA has given up on its plans to get the *Gemini 8* flight off in the first quarter of next year. Official schedules—prior to the *Gemini 6* failure—called for the flight to be attempted in January or February.

With a total of at least two to three weeks of testing beginning in February, it is almost certain that the flight will not be attempted until April at the earliest. Further slippage is also possible if unexpected problems develop during the test series.

Gemini 8, with its astronaut crew of Neil Armstrong and David R. Scott, will be the first U.S. attempt to dock two orbiting vehicles. It will also be the second U.S. extravehicular mission.

● **Easing rendezvous**—Meanwhile, one rendezvous expert at the Manned Spacecraft Center feels that the *Gemini 6* will be boosted into space next week with a higher probability for achieving rendezvous than it had prior to the *Agena* failure on Oct. 25.

He bases his opinion on a number of relaxed pre-mission constraints that give mission controllers more latitude in choosing the precise moment to lift *Gemini 6* off the pad.

Two significant procedural changes are:

—A 25-minute built-in hold at T-3 minutes, just before the count moves into automatic sequencing, and

—A willingness to allow *Gemini 6* to circle Earth up to 23 times—or 1.5 days—to catch up or move "in phase" with the *Gemini 7* spacecraft for rendezvous.

Howard W. Tindall, Jr., of MSC's Mission Planning and Analysis Div., explained it this way:

"We've taken all the 'fat' out of the count and put it where it will do the most good—at T-3 minutes. If everything goes well, we may have to sit and wait for *Gemini 7* to come overhead, but if the erector fails to come down or there is some other problem, we will have 25 minutes to get the problem squared away."

Agreement on the built-in hold near the end of the count was long in coming, he explained. Doctors did not want to keep the crew in feet-up position during the extra time because this could compromise their reaction time during a launch abort situation. Others felt it was not needed.

The crew, he said, will now be inserted into the spacecraft later in the count. The time they spend in the cabin before liftoff, however, (provided they lift off on time) will remain same as before.

• **Better angle**—Shortly after the dual *Gemini 7/6* mission was announced, MSC trajectory analysts ran computer studies to seek out the most ideal inclination angle for *Gemini 7's* orbit. At first they chose to launch *Gemini 7* on an 82.5-deg. azimuth to incline its orbit 29.06 degs. to the equator. "The advantage of the higher inclination angle was that instead of a 135-minute launch window, we could have one that was 155 minutes long. This assured us of two launch opportunities, or window 'panes,' for every single day," he said.

The 29.06-deg. inclination angle, however, moved most of the *Gemini 7* plane during ideal launch times farther north of the *Gemini 6* launch pad putting "a greater demand on the propulsion capability of the *Gemini 6* booster" to steer out out-of-plane error, he said.

It was a "tradeoff," he explained, and mission planners chose to stick with the 28.87-deg. inclination angle originally contemplated for the *Agena* vehicle during the aborted *Gemini 6* mission in October.

Tindall said there will be two window panes on the ninth day after *Gemini 7* liftoff, but only one on the tenth day. "The chances are that if we miss the ninth day launch, we would probably move to the eleventh day," he said. The panes existing on the eleventh day, however, will last not quite 47 minutes each. Elapsed time between the two panes amounts to about three-quarters of an hour, he added.

"We stretched the window panes through a willingness to rendezvous later than when we had planned earlier," he said. Earlier, the catch-up time was restricted to 16 orbits, or about one day. Now, the *Gemini 6* will be allowed to spend more time catching up—up to 23 orbits—to get into phase with the passive target for rendezvous. "We found that we were still pretty well over the range after 23 orbits of catch-up. This extended the launch panes an extra 12 minutes each."

• **Speeding catch-up**—Should the *Gemini 6* be so late in getting off the pad that even 23 orbits of catch-up would not move it into favorable rendezvous position, the plan calls for launching the *Gemini 6* into a lower orbit to give it a relatively faster catch-up rate, he explained. "Instead of launching the spacecraft into an orbit with a 146-n.m. apogee, we could drop the apogee down to as low as 120 n.m. if necessary. Beyond this, it may be best to wait for the next launch opportunity and, on days with two launch panes, this amounts to only a 45-minute wait between panes." He added, "if you start the count on time, the chances of going on that same day are really quite good."

Plans call for circularizing *Gemini 7's* orbit on the fifth elapsed day of the spacecraft's flight. "By that time, *Gemini 6* will have completed its simulated flight and the operations people will know its status of flight readiness," he said. That happens to be "coincidental," he added. "The real purpose in circularizing that many days ahead of the *Gemini 6* launch is to establish the pattern of launch panes."

"The start of a pane depends on when *Gemini 7* comes across the Cape. This is governed by its orbital period, which, in turn, is affected by spacecraft altitude . . . the higher it is, the longer it takes to go around and the later it will be in getting there," he continued.

• **Within 2 ft.**—After *Gemini 7* is launched into an 87-183 n.m. orbit, Borman will attempt to stay with the second stage of the *Titan II* while Lovell will make infrared measurements of the booster, using the special Dept. of Defense equipment also used on the *Gemini 5* mission. The station-keeping and experiment maneuvers will lower spacecraft apogee to about 180 n.m. within the first three orbits. At third apogee, Borman will apply posigrade thrust to lift perigee up to 108 n.m. "We're hoping that the apogee will decay to about 161 n.m. about the time we plan to circularize *Gemini 7*," he said.

The amount of apogee decay will be controlled by adjusting the perigee altitude. "If it's dropping fast enough, we can lower perigee into the atmosphere to encounter sufficient drag," he explained. This, he said, will also give them control in the event of an underspeed or overspeed condition during spacecraft orbital insertion.

Although the two vehicles will not dock, they plan to be "from one to two feet apart." *Gemini 6* pilots Walter M. Schirra and Thomas P. Stafford will each take turns at separating from the spacecraft and moving back in for a "simulated" docking on the day and night sides of the orbit. Following this, *Gemini 6* may become the "passive" target while *Gemini 7* attempts to stay with the other vehicle in station-keeping exercises. ■

Two Teams Form for Apollo Applications Bidding

AT LEAST TWO TEAMS will be among the bidders when the request for proposals for systems definition of payload integration of the *Apollo* Applications program is issued by NASA's Marshall Space Flight Center.

It has been learned that TRW Systems and Chrysler Corp. have signed an informal agreement to pool their resources and skills in an effort to win the contract.

The other team is composed of IBM and The Boeing Co.

Two other firms, General Electric and General Dynamics, decided to go it alone and submit their own bids.

Issuance of the RFP has again been delayed. It may now come as early as Dec. 15, but NASA sources say it could slip into January.

Reportedly, the RFP will be sent to 25 companies, many of which are expected to enter the competition.

The first procurement action will involve a 4-6-month feasibility design study. At least two firms are expected to perform parallel contracts. Then one firm will be selected for a systems definition award. The same company will be named prime contractor when hardware development is initiated.

Marshall will have field-center responsibility for payload integration of the AA spacecraft's Lunar Excursion Module. Manned Spacecraft Center will be the field center responsible for integration of experiments into the spacecraft's Command and Service Modules.

• **McCall to manage**—In another AA development, Marshall announced that Jerry C. McCall, currently deputy director of R&D Operations at the center, will be named manager of the program at that center. Stanley R. Reinartz, manager of the recently cancelled *Saturn IB/Centaur* office, will serve as his deputy.

Paul J. Defries, director of AA studies in Marshall's Advanced Systems Office, originally was considered to have the inside track for the manager's job, but apparently has been moved out of the program.

AF Gets Two OV's for Dual Launch

Pair of research satellites delivered by GD/Convair are due to be launched on Atlas Jan. 13; new experiments described

by Willard E. Wilks

TWO AEROSPACE research satellites scheduled for a dual launch early next year have been turned over to the Air Force Office of Aerospace Research (OAR) by General Dynamics/Convair, San Diego, Calif.

The vehicles are the *OV-1-4* and *OV-1-5*, slated for a two-in-one launch with an *Atlas D* from Vandenberg AFB, Calif., Jan. 13.

Aboard the *OV-1-4* will be three experiments developed by Air Force Systems Command. The Aerospace Medical Div., Brooks AFB, Tex., will furnish two experiments to determine growth rates, gas exchange and any adverse effect on photosynthetic organisms and small vascular plants in a zero-g environment. Another experiment will study thermal coating characteristics. The *OV-1-5* will contain an experiment package developed by OAR's Cambridge Research Laboratories (CRL) to study background optical radiation.

The *OV-1-5* experiment is tied into other programs and efforts important to Air Force defense objectives, and two instruments are similar to those included for CRL in the on-board *Gemini 7* experiments. This aspect of the *OV-1-5* mission relates to reconnaissance and guidance, according to AF sources.

● **Background study**—The background optical radiation experiment, accounting for the total 102-lb. payload weight, is mainly in the infrared region and is comprised of five optical sensors—three looking at the Earth, others at the horizon. The Earth-oriented sensors include a multi-filtered radiometer that observes in discrete bands between 1-3 microns, an interferometer spectrometer which scans in two wavelength regions—one seeking spectral information in the 1 to 3-micron region, the other simultaneous regions in the 3 to 12-micron region—and an a-c radiometer which will measure optically in the 1 to 3-micron region.

The two instruments looking at the horizon include a filter wheel radiometer with 30 different filter positions—10 in the ultraviolet visible region, 10 in the 1 to 3-micron region, and 10 in the 3 to 30-micron region—and an interferometer spectrometer. The latter views in the 8 to 30-micron spread, has a two-degree instantaneous field of view, and has a rotating scanning mirror that sweeps 17 degrees back and forth across the horizon.

The *OV-1* package will make important background and horizon measurements to determine thermal characteristics of the Earth and atmosphere. One objective is to investigate the general infrared region with the horizon scanners. Purpose would be to see if there may be sharper gradients or an optimum wavelength that can be used, rather than the broader wavelength employed in current horizon sensors in guidance and navigation systems. Current systems sense radiation from the carbon-dioxide band. A thermal mapping portion of the experiment will make measurements enabling water vs. land vs. mountain vs. desert distinctions. It may also help determine whether certain wavelength regions are better than others for viewing the Earth from satellites.

● **Plant package**—*OV-1-4* will carry an experimental package of two plants—one chlorella alga and one duckweed, expected to reproduce a number of generations over the 30-day experiment. The experiment is instrumented with oxygen, carbon-dioxide, temperature and pressure sensors, and photocells to indicate growth rate.

The experiment is not designed to extropolate directly to man. However, it will be useful in determining long-term cellular effects of weightlessness on organisms, possibly including man, and in studies concerning use of plants for space life support.

The thermal coating experiment portion of the *OV-1-4* package consists of a series of wafers with various types of paint, patterns and material coatings. Objective is to determine effects of long space exposure. ■

Aerospace Systems in Van of 'Fantastic' Computer Applications Growth

LAS VEGAS, NEV.—Hardware innovation in computers is slowing down, but in the current $6-billion market, applications are expanding "fantastically," with on-line aerospace systems in the forefront.

Speakers put forth these views at the 1965 Fall Joint Computer Conference, held here last week.

Discussing the next 10 years in computer development, J. P. Eckert, a vice president of Univac Div. of Sperry Rand Corp., foresaw the use of some new components such as integrated circuits and film memories. For the most part, however, he predicted refinement of ideas already being developed, especially as regards speed and storage.

Eckert said he thought there would be very few new system ideas, that there would be continuing problems with input-output devices, and that the importance of small computers would increase. He predicted that progress in "software" would be less than expected.

● **Improvements**—On a basis of performance per dollar, Eckert suggested that internal high-speed memory would improve 10-20 times; logic circuits, magnetic tapes and mass storage 5-10 times.

Robert Hubner, of IBM Corp., agreed that computer speeds could not go on increasing. He suggested that one effect of the slow-down of hardware development would be to lengthen a computer's installed life. His view was that even if technological development were to stop now, computer sales would continue to boom. "The market is fantastic, and the market is fantastically growing," he emphasized.

Major interest at the conference focused on on-line time-sharing systems. A description of parts of the large Multiplexed Information and Computing Service (MULTICS) was given by Bell Telephone Labs, Project MAC at Massachusetts Institute of Technology, and the General Electric Co. GE took the opportunity to formally announce its GE-645 system (used in MULTICS). Up to 300 persons can compute on this at the same time. BTL ordered three dual-processor versions last year at a cost of $23 million.

Technical Countdown

ELECTRONICS

Thermopile Wavelength Dependence Observed

Scientists at the National Bureau of Standards Institute for Basic Standards have observed a signficant wavelength dependence in thermopiles used to detect far-ultraviolet radiation. Thermopiles are generally calibrated with visible and near-infrared radiation on the assumption that the sensitivity will not change as the wavelength of the radiation changes. The wavelength dependence was traced to the photoelectric effect by R. G. Johnston and R. P. Madden in studies sponsored by NASA. The finding indicates that corrections should be made for thermopiles calibrated in the visible but used to detect radiation in the far-ultraviolet. NBS experts found that as utraviolet radiation of wavelength below 1,600 Å strikes the black absorbing material of the thermopile, the energy of collision causes electrons in the black material to be ejected. This photoelectric effect occurs only with short-wavelength UV light and the ejected electrons carry away as much as 5% of the incident UV energy, resulting in a substanial variation between ultraviolet and visible light measurement.

Ultraviolet, Pulsed-Gas Laser Developed

A 50-kw ultraviolet pulsed-gas laser is being perfected at Avco's Everett Research Lab. Based on a 200-kw experimental lab model, the new laser uses commercial grade nitrogen to produce self-terminating pulses lasting 10 to 20 nanoseconds with a variable repetition rate of one to 10 pulses/sec. The output wavelength is 3,371 Angstroms, and the output bandwidth is less than one Angstrom. Q switches are not necessary because the pulse is self-terminating. The driving electric field is applied across the discharge channel perpendicular to the laser's output beam. This cross-field geometry means that high electric fields can be produced over a large volume of gas with easily manageable voltages. The unit has two electrodes running the length of the discharge channel. The fast-rise current pulse is delivered from a capacitor bank to the laser by 11 transmission lines. The laser's discharge channel projects a UV beam ⅛ by ⅛ in.

Radiation Improves Solid-State Devices

Irradiation of some solid-state devices, notably solar cells, has resulted in their eventual re-use with better characteristics than they had originally. The Electronics and Control Division of NASA's Advanced Technology Office is currently trying to find out why some solar cells can be irradiated, heated, re-annealed and still show up better than ever. It is hoped to find a way to reproduce the phenomena consistently at will on all solid-state devices. Effect was first noticed by accident on strain gages at Langley Research Center.

MATERIALS

Space Effects on Optical Materials Studied

The contaminating effects of the space environment on optical materials similar to those used on the *TIROS* and *Nimbus* weather satellites will be examined under a follow-on contract by Avco Research and Advanced Development Div. The program will investigate changes in the infrared optical characteristics of semiconductors alternately cleaned and exposed to contaminating low-pressure gases in a simulation chamber. The $50,000 contract is with NASA's Goddard Space Flight Center.

Probeless Flow Measurement Perfected

A crossed-beam correlation technique that permits measurement of the statistical properties of turbulent flows without the introduction of instrumentation into the flow field has been developed by IIT Research Institute. A feasibility study using a subsonic jet exhaust has been completed and the results agreed with those obtained previously using more conventional instrumentation. The work was sponsored by NASA's Marshall Space Flight Center. Particular applications include space vehicle base heating, acoustic loads and industrial research into the aerodynamic and acoustic problems associated with jet engine and rocket exhaust flows.

SPACE MEDICINE

Hyperbaric Chamber Operational at SAM

The first hyperbaric chamber installed by the Air Force for treatment of decompression sickness is operational at the School of Aerospace Medicine, Brooks AFB, Tex. One of eight that will be installed by the Air Force at various bases, the aluminum structure is 5 ft. in diameter and 12 ft. long, with two locks. The chamber will be used for treatment of disabled flyers, for training, and for conducting some research programs.

AF Measures Vibration Effects

Air Force physicians hope to get exact data on how vibration of spaceflight launches affects the circulatory system through an experiment under way at the Aerospace Medical Research Laboratory. Subjects with catheters inserted in their arms are strapped in vibrating chairs and undergo vibrations up to 10 cps for durations up to three minutes. In one test, the subject has one catheter inserted in his arm to within three inches of his heart, another near his armpit.

Lockheed Develops Exercise Device

Lockheed Missiles & Space Co. suggests that astronauts use a simple exercise device called an "Exer-Genie" to keep physically fit. The device consists of a small metal cylinder through which a nylon line is pulled using wooden handles or stirrups at the ends of the line. The other end would be attached to the floor or wall of a spacecraft. Force required to pull the line can be varied from zero to 400 lbs. and can be measured by a strain gage. A number of exercises have been devised with the apparatus.

PLSS Passes Manned Mission Test

The *Apollo* portable life-support system (PLSS) developed by United Aircraft's Hamilton Standard Div. has passed a test in which the pack was run for the three-hour period of a typical extravehicular mission in a vacuum chamber at 180,000 ft. altitude. Systems engineer Richard A. Paul, working on a treadmill, burned energy at 2,000 BTU's an hour for more than half the test period. The pack is designed to handle a total metabolic load of 4,800 BTU's.

Grumman Testing Surface Mobility

Firm demonstrates fixed-base and mobile simulators developed in-house; will study remote MOLAB operation

Both a mobile and a fixed-base simulator are being developed by Grumman Aircraft Engineering Co. as part of the firm's continued in-house study of lunar surface mobility.

According to Ed Markow, Grumman project manager, tests planned for the immediate future will concentrate on how man can operate a vehicle on the Moon and conduct experiments.

Using the fixed-base simulator, the Bethpage, N.Y., firm will study possible Earth-based operation of the Mobile Lunar Laboratory (MOLAB) to bring it to an *Apollo* landing site. Under the Lunar Excursion Module (LEM) truck concept, a MOLAB would first be delivered on top of the LEM descent stage. Astronauts would arrive later, as will be done on *Apollo* flights.

The mobile simulation facility, located at the company's Peconic Airstrip near Calverton, N.Y., consists of two acres of dust and cinders, arranged to resemble lunar craters, on which a full-scale MOLAB mockup is driven. This facility validates tests run in the fixed-base simulator, according to Markow.

- **Recent demonstrations**—At demonstrations last week, Grumman engineers showed how the MOLAB could be guided around lunar craters, using both of the simulators and under varied lighting conditions. The vehicle consists of two modules, each supported by a pair of independently driven 5-ft.-dia. metalastic wheels, a proprietary Grumman device.

Overall length of the vehicle is 31 ft. and the wheel tread is 140 in. The forward module provides space for two astronauts, control equipment and experiments. The power supply is in the rear module. An actual system to operate on the Moon would weigh between 7,000 and 10,000 lbs. and provide 30 cu. ft. for 500 lbs. of experiments, Markow said. It would be capable of operation on the Moon for two weeks, traveling up to 250 miles. Top speed would be 10 mph.

The mockup has a turning radius of 45 ft., which will be decreased to 37 ft. in a couple of weeks, Markow added. Although the studies have not been concerned with getting over obstacles, he said, the vehicle theoretically could climb a 22-degree slope and could get over crater walls as steep as 45-50°.

- **Advanced MOLAB**—Also under study—but not even in the construction stage—is a three-module MOLAB that could climb even steeper slopes. In the test item, the rear module contains a gasoline engine to drive a generator and provide power to the wheels' electric motors. Fuel cells would be used on the Moon.

Grumman has put some $750,000 of its own money into the program after losing the NASA study contracts. This includes $250,000 for hardware and $500,000 in engineering effort. The Marshall Space Flight Center studies were won by Boeing Co. and Bendix Corp., but both Grumman and Northrop Corp. have continued on their own. However, Grumman does have one Marshall lunar surface study to examine human factors of surface transportation.

The fixed-base simulator consists of a moving belt, illumination system, TV camera and display screen, vehicle motion signal generator, lunar vehicle cockpit mockup and a computer to create the illusion of driving the MOLAB on the Moon. The belt is 5 ft. wide by 22 ft. long and represents a lunar surface area 125 ft. by 550 ft.

Sunlight is simulated by eight 1,000-watt 3,200°K lamps, placed to simulate various lunar lighting conditions. A hydraulic system translates movements of the wheeled TV camera to the simulator cockpit so the Earth-bound astronauts get an immediate feeling of how rough the ride would be on the Moon. ■

Aluminaut Sets Depth Record

REYNOLDS METALS Co.'s Aluminaut, designed to reach depths of 15,000 ft., has set a new submarine depth record by going down nearly 1¼ mi. off Great Abaco Island in the Bahamas. The vessel has also confirmed existence of a cold, southerly current flowing beneath the Gulf Stream in the Straits of Florida, Reynolds says.

AA Experiment Proposals Studied

NASA headquarters space medicine personnel defining groups of tests from original 23 suggested; MSC to let contracts

EXPERIMENT GROUPS are now being defined for the biomedicine/behavioral aspects of the *Apollo* Applications program at NASA headquarters space medicine group.

At the same time, machinery is being set up for evaluation of new proposals as they come into the program. A number of critical decisions in this area will be made soon.

Contracts for supporting research and development and experiment hardware will be let from the Manned Spacecraft Center, Houston.

Specific measurements to be made on each flight will depend on the capability of the flight, and whether or not a physician is aboard. In addition, the experiments will be classed in two general areas, those designed to get information on suspected problem areas, and those that survey the total status of the astronauts to pinpoint any problems that might be developing before they become manifest.

A tentative list of 23 experiments (M/R Nov. 29, p. 54), which was drawn up in August for the AA program, is now being broken down into smaller tasks or measurements, since it is unlikely that in early flights it will be possible to fly the entire experiment.

- **Experiment types**—The original 23 included two on neurological functions, eight on cardio-respiratory functions, five on metabolic functions, one on endocrine function, three on hematological function, and one on microbiological organisms.

These experiments had the goals of scientific physiological experimentation, development of standards applicable to space medicine, development of predictive indices, validation of protective measures and remedial techniques, and development of hygienic standards for long-term missions. Three additional experiments were suggested for the behavioral area.

The experiments have now been separated by the headquarters space medical group into eight general areas, some with subdivisions. These include cardiovascular, with subheads of assessment, provocative testing, and corrective measures.

In the metabolic and nutritional area, there are general studies, muscular status, mineral metabolism and skeletal status, and general metabolic and nutritional. Hematological studies have subcategories of general studies, cellular changes, body defenses, and hemostasis.

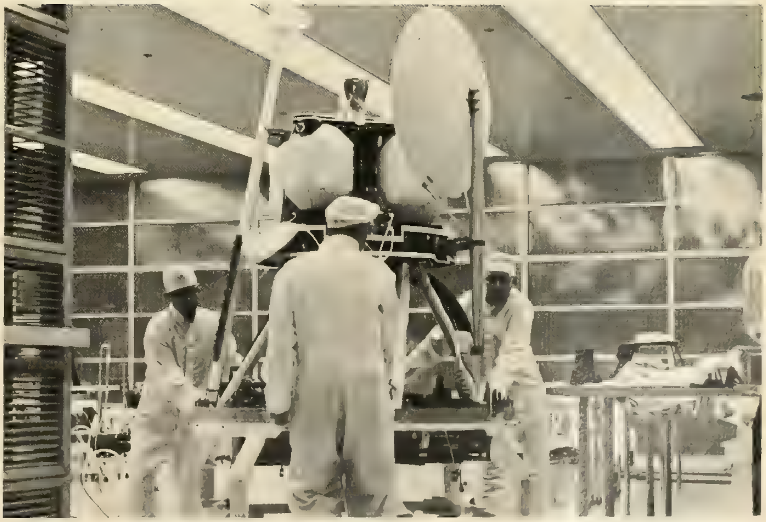
The remaining categories are neurological, respiratory, endocrine, microbiological, and behavioral.

Three tentative behavioral experiments outlined in the August review were 1) perceptual processes and resulting effect on performance, 2) phychomotor functioning and resulting effect on performance, and 3) higher mental processes and resulting effect on performance.

- **Well researched**—The scope of the experiments in the medical and behavioral area is among the best defined in the AA program because of preliminary work done in 1964 by the Space Medicine Advisory Working Group.

This group held a series of eight meetings lasting two and three days at various NASA centers working on recommendations for medical experiments in an orbiting research laboratory.

Also considered were recommendations by the Biomedical Experiments Working Group, which met in 1963, and the results of contractual work done by Republic Aviation and North American Aviation on biomedical and human factors requirements for a manned Earth orbiting station, and Lockheed's biomedical measurements of man in space. ■



First Flight-Type Lunar Orbiter Assembled

FIRST Lunar Orbiter built to flight specs leaves Boeing clean room. Only the spacecraft's camera subsystem is missing. The spacecraft will be tested in a vacuum chamber to gauge its behavior in a space environment. First Moon photo mission is set for mid-1966. NASA's Langley Research Center directs project.

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MINAC 6—**For Surveillance**—A short range version of the MINAC 5, uses Doppler inputs and provides present position information while driving standard BDHI instruments. Digital data representing present position is available for data annotation. Flight tested in Mohawk OV-1.

MINAC 7—**For Helicopters**—A modification of MINAC 5, this computer accepts Doppler data and provides present position in latitude and longitude coordinates, map drive display and digital form. It also provides BDHI data.

MINAC 11—**For High Performance Aircraft**—Accepts inertial platform data and computes and displays present position and destination position in latitude and longitude coordinates plus course and distance to three resettable destinations. It has accumulated many hours of flight test in the F4 aircraft.

AN/ASN 24(V)—**For Logistic Transports**—This is the first operational airborne general purpose digital computer, and it is now in service aboard the C141. It computes and displays present position based on the following sensor inputs—automatic sextant, air data computer, Doppler, gyrocompass, TACAN, LORAN and radar. In addition to navigation, it also performs air drop computations.

GPK-33—**For Space Boosters**—This is a small, compact, ruggedized computer similar to the ASN 24. It is an integral part of the Centaur inertial guidance system and generates steering and engine cut-off signals based on the output of the gyro-stabilized platform.

And there are more—A microelectronic version of the AN/ASN 24 designated L90-1B is in flight test. A DDA computer similar to the MINAC series, utilizing microelectronic circuitry, is being flown. And then there is the new generation now being designed.

We want to tell you more about this lively field of airborne computers, so just drop us a line soon.

NOTE: *MINAC is a family of hybrid computers combining the best features of state-of-the-art analog computers with high accuracy digital integration. Versions have been produced for Doppler and inertial platform inputs and for display in latitude/longitude or UTM coordinates. Digital output for data annotation is also available. All computers in this series include field replaceable modules and self-test features.

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Vacuum Chambers To Check Apollo 011

Built by division of Pennsalt Chemicals, structures are less sophisticated than those at Houston and are not involved in research

by Sue Butler

TWO VACUUM CHAMBERS nearing operational status in the Kennedy Space Center's Manned Spacecraft Operations Building will be used to check *Apollo 011,* scheduled to fly on *Saturn IB* No. 202, the uprated *Saturn's* second unmanned flight expected sometime in 1966.

The chambers—one for use by North American Aviation for altitude tests on its *Apollo* Command and Service modules, the other for Grumman Aircraft Engineering Corp., manufacturer of the Lunar Excursion Module—were built by F. J. Stokes, Philadelphia, a division of Pennsalt Chemicals Corp., at a fixed-fee contract price of $3,429,754.

Construction began with on-site work in October, 1964, and was completed on July 29.

North American is in the process of activating its chamber by installation of equipment such as communication systems, hard lines for oxygen supply, and cooling systems for spacecraft radiators.

The Grumman chamber is being readied for a LEM adapter shroud fitting.

The chambers, each 33.5 ft. wide and 58 ft. tall, are designed to simulate altitudes of up to 250,000 ft.

Fabricated in "304" stainless-steel sections 0.5 in. thick, each chamber consists of five 10-ft.-high rings welded together and capped by a dome. The chambers are not insulated. A turntable at the floor permits rotation of the spacecraft to facilitate serving and observation.

To permit inseration of spacecraft modules, the 27-ton dome is lifted off by a crane. Two 25-ton cranes, one with 85-ft. hook height, the other two with 50-ft. each, serve both chambers.

Air will be pumped out by 16 mechanical pumps made by Stokes and five vacuum blowers made by Rootes Connersville at a rate of 3,000 cu. ft./min. This will take the chamber from the normal atmospheric pressure at sea level to just 15 microns in 45 minutes.

- **Operational only**—These chambers are not as sophisticated as the two in Houston's Manned Spacecraft Center, in which the astronauts can work out to 420,000 ft.

In the first test, each chamber will be run up to 210,000 ft.

"The research is being done at Houston. Here we make only the operational checks," said Frank Harsche, NASA project manager for the KSC chambers.

Attached to each chamber are two airlocks. An inner observation lock 8 x 8 x 14 ft. serves project officers observing the tests and rescue specialists from Bendix Corp., which operates the facility for NASA. A 6 x 8 ft. outer lock is for rotation of observers without loss of vacuum.

When sufficient air has been pumped out of the chamber to simulate 8,000 ft. altitude, the door between observation lock and main chamber will be sealed and the cell raised to higher altitude.

Instruments in the airlock and the nearby control room are designed to help watchers keep an eye on the tests' progress. Charles C. Hicks, supervisory Bendix engineer, said extra care will have to be taken because the cryogenic liquids, high-pressure gases, high vacuums and explosive atmosphere will combine to create highly hazardous conditions.

If an emergency occurs inside, the chamber will immediately be vented to 25,000 ft. while the altitude in the airlock will be raised to equalize that pressure. Oxygen-masked rescuers will then be able to enter the chamber. The whole operation from emergency to rescue has been clocked in dry runs at just three seconds, according to Hicks.

- **Check list**—Tests now planned for spacecraft *011* center largely around environmental control and leakage checks.

Art Busch, chief of the fluid and mechanical division of KSC's Spacecraft Operations, and Ed Wright, systems engineer in the environmental control system, told M/R that:

—Checks will be made on the recirculating water-glycol cooling system. The environmental-control cooling system maintains proper temperature controls for both the electrical devices and the astronaut suit-cabin air system. Both methods of heat dissipation—water evaporation and space radiator—will be checked out in order to verify heat balance within the environmental-control cooling system.

—There will be checks of cabin and suit pressure controls for ascent, for deep space and for descent.

—Fuel cells will be checked, but will not be loaded with liquid hydrogen and liquid oxygen. Instead, gaseous hydrogen and gaseous oxygen will be supplied to the cells from an external source. Functioning of the cells with cryogenic liquids will have been checked out earlier at the cryogenic test facility, and the chamber test is intended merely to determine heat-balance characteristics of the fuel cells and their operability at altitude.

—The environmental control system will be checked, using the suit-loop stimuli generator that thermally and chemically simulates the astronauts. The "canned man," more sophisticated than its forerunners, will simulate heat, carbon dioxide, water generation and oxygen consumption.

—Altitude leakage measurements will be made.

On subsequent *Apollo* flight hardware, man-machine interface, communications and biomedical readouts will be checked. Waste will still only be simulated, because the pilots are not expected to remain in the chamber for more than 6-8 hours at one time.

At the present, preparatory sea level tests and checks are being accomplished, Busch said.

He declined to specify how long altitude chamber tests will take on future unmanned and manned spacecraft systems, but the minimum time appears to be 10 days—allowing ½ day for positioning the *Apollo* modules, one day for environmental control system functional tests, one for cabin leak checks, about a week for several runs to altitude, and one day for disconnect. ■

Steerable Parasail Tests Point to Use in Vietnam

SUCCESS of recent tests with newly developed radio-guided parachutes has led Air Force project officers to believe that a requirement for units to pin-point air-dropped supplies in Vietnam may soon be forthcoming.

The steerable, 51-ft.-dia. parasail/parachute combination has been developed by the Flight Dynamics Laboratory at Wright-Patterson AFB, part of the AF Systems Command's Research and Technology Div.

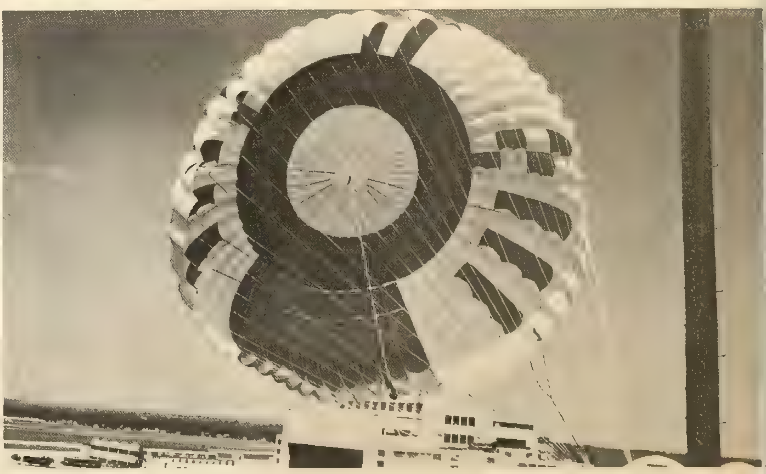
The unit has an on-board guidance and control system, basically an electronically controlled servo mechanism which controls the response of the chutes' risers to ground commands. The guidance unit weighs 115 lbs. A ground-based beacon transmitter, which weighs 30 lbs., is used to guide the parachute to the intended impact point and can be operated manually or automatically. The parasail provides 10 ft. of guided horizontal flight for each 10 ft. of vertical drop.

In most recent tests, seven drops were made from C-123 aircraft over the Bavarian Alps to demonstrate the concept's usefulness in darkness and fog. Impact zone was 2,000 ft. below the mountain ridge line at the bottom of a narrow valley. A project spokesman told MISSILES AND ROCKETS that five of the drops were successful and that two failed "due to human error." One drop landed within 45 ft. of the beacon. The others were at about 150 ft.

The parasails are equipped with red, green, and white lights for manually controlled night drops.

More than 60 tests of the parasail homing cargo delivery system have been made to date at AF test sites in the U.S. With release of the system at 5,000 ft. at an aircraft speed of 130 knots, closest previous drop accuracy was 69 ft. A 15-ft. ringslot chute is used to pull the 2,000-lb. payload from the aircraft and to open the main chute.

Demonstrations thus far have been for potential user commands within the AF. Though the project is still officially in the development stage, officers say they anticipate a requirement soon for Vietnam, possibly coming through the new AFSC Liaison Office in Saigon (M/R, Oct. 25, p. 10), which has been established to speed the process by which new techniques and hardware can be brought to bear in Vietnam. ■



PERSONNEL AT Wright-Patterson AFB static-test 51-ft.-dia. parasail/parachute.

ENGINEERS
PHYSICISTS

POLARIS SYSTEMS EVALUATION

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A Special Report on Space Communications will be published by MISSILES AND ROCKETS on January 31, 1966. This report will give comprehensive coverage of the use of advanced satellite systems for military and commercial telecommunications.

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Publication Date: January 31,1966 **Closing Date: January 17, 1966**

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missiles and rockets
THE WEEKLY OF ADVANCED TECHNOLOGY

PCM System To Get Apollo Test

Telemetry unit developed by Radiation, Inc., uses almost all integrated circuits, meets exacting size and power demands

by Charles D. LaFond

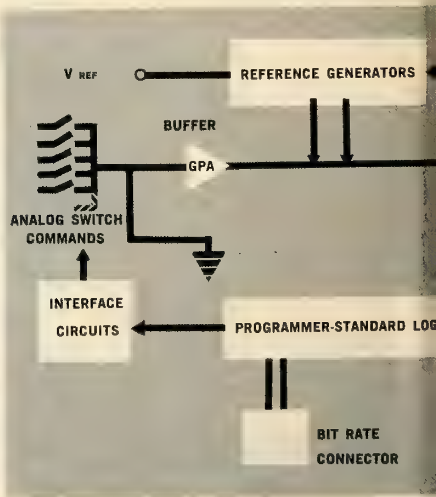
MIAMI BEACH, FLA.—A nearly all-integrated circuit PCM (pulse code modulation) telemetry system has been flight-qualified by NASA's Manned Spacecraft Center, Houston, for the unmanned *Apollo* flight tests beginning next month.

Funded in part by NASA, the 1.4-lb., 33-cu.-in. systems were developed by Radiation, Inc., of Melbourne, Fla. First public showing of the 1.7-watt instruments was here in November during the International Space Electronics Symposium.

The units provide a 98-analog-channel multiplexer and encoder plus two digital channels for frame synchronization.

● **Nine-month effort**—A contract for development of three of the micro-

LEFT: PCM telemetry system (under technician's left hand) developed by Radiation, Inc., for NASA is first Apollo flight-qualified unit employing new



miniaturized PCM systems was awarded to Radiation by the Manned Spacecraft Center in October, 1964.

Because the units are to be employed in the early unmanned *Apollo* spacecraft test flights, a nine-month delivery to MSC was required. With a give-away bid of only $33,000, Radiation took the project and has borne much of the development costs of the equipment. The reason: to be first in space with the first completely microcircuited telemetry using only RI-built integrated circuits.

Reportedly, all NASA specifications were met or bettered in the final product, particularly in size, weight, power consumption and accuracy.

- **Design needs**—Two key design goals to be met under NASA specification requirements were size (50 cu. in. max.) and power (2.5 watts max.). Power consumption was recognized as a major design and performance determinant, according to Dudley Garner, the project engineer, because of the expected high ambient operating temperatures—above 200° F.

Use of integrated circuits was demanded by the size limitations, but it was decided to employ some discrete components wherever they offered a significant performance advantage. A final configuration employing stacked planar assemblies for integrated circuits and hybrid modules was selected.

- **Novel approach**—To overcome the inherent performance limitations of linear integrated circuits, Garner disclosed, several design tricks were employed.

The analog-to-digital converter was clamped synchronously to a ground reference between measurement intervals. Also, a correction signal was employed to direct the input to the error detector to read zero. The correct signal is maintained by the error-signal-memory circuit for the duration of a subsequent measurement of an analog sample.

In tests to date, Radiation has shown that switching-point resolution and drift over the full temperature range experienced in operation are less than two millivolts. (Qualification tests of the converter have shown that by extending the converter design concept, a 10-bit accuracy could be obtained.)

- **Circuit and system fabrication**—Both the general-purpose amplifiers (GPA) and the interface-circuit semiconductor integrated circuits were developed and produced by Radiation. Active elements are metal-oxide semiconductor transistors—selected for their low offset and drive simplicity. Also, for the mutliplexer application, a further limitation was created by the requirement for a one-megohm isolation between analog inputs when system power is turned off.

All IC types used in the system were first subjected to a six-month RI test program to establish device-parameter stability, the firm said.

Amp, Inc.-developed miniature spring sockets, soldered to the printed-circuit planar assemblies, serve to interconnect the cards. Pad orientation is such that interconnections between cards are geometrically accurate and in line with the pads on all other cards requiring the same connection or circuit continuity. Solid bus wires are inserted through all the sockets for electrical contact. Where no electrical connection is needed, a relief hole is employed, providing an insulated passage for the wire.

Card spacing throughout the entire assembly is 0.150 in. center to center. The result, assert RI engineers, is a versatile, three-dimensional interconnected lattice offering considerable flexibility in the layout of printed circuit cards. Also, they feel, it minimizes the amount of space needed for interconnections and permits closer spacing of card assemblies when they are stacked in the final configuration.

Following final circuit checkout, the whole assembly is placed under compression, partly to provide a low dynamic response to both shock and vibration.

- **Final characteristics**—The final PCM system, including power supply, dissipates 1.7 watts, or about 0.8 w below the space agency requirement of 2.5 w.

Size was reduced from the required 50 cu. in. to 33; weight from 2.4 lb. to 1.4.

Other major performance characteristics include:

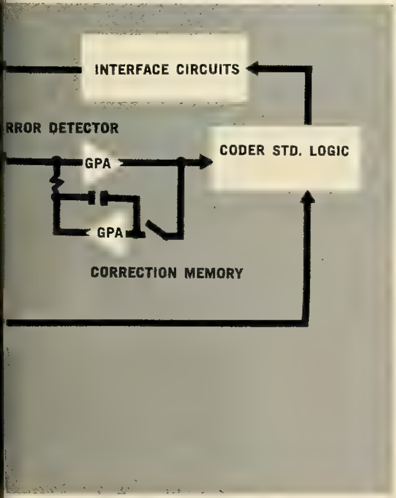
—Signal search; 0-5v full scale;
—Variable sampling rate; 1-32/sec.;
—Output bit rate; 800, 1,600, 3,200, 6,400, 12,800, and 25,600 bps;
—Accuracy: ±0.6%, three sigma limits.

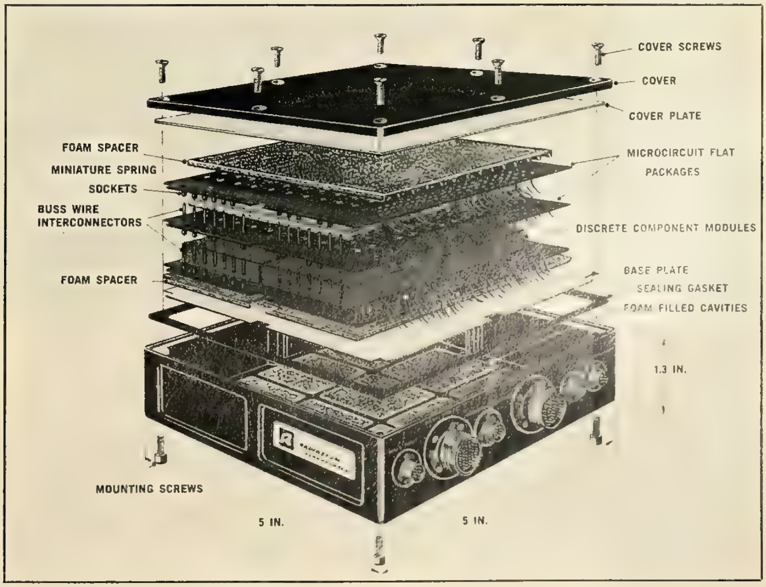
The encoder provides for an 8-bit binary word. The output format is an NRZ-type "C" continuous bit stream.

A mean-time-between-failure figure of 10,000 hrs. is claimed by RI with a maintenance and adjustment free service life of 2,000 hrs. System storage life is estimated at three years.

Although not man-rated, the Radiation PCM system has successfully passed a rigid physical exam. The firm stated a system temperature operation range of —30° to 230°F. ■

integrated circuit design. BELOW: Simpli- lock diagram of system. RIGHT: Exploded of unit, which occupies just 33 cu. in.





Ryan Sets Up New Electronics Branch

Move reflects 20% growth in space electronics over last year; responsibilities to include Surveyor, Saturn and LEM systems

by Rex Pay

SAN DIEGO, CALIF.—Reflecting a 40% increase in its electronics business in the past year, half of it in space electronics, Ryan Aeronautical Co. has set up a new Electronic and Space Systems Dept. headed by J. Richard Iverson.

The department is responsible for such electronic systems as the *Surveyor* and Lunar Excursion Module (LEM) landing radars, the *Saturn* radar altimeter, an infrared ranging instrument and an airborne radar reflectivity system. In addition, it contains the Ryan Space Structures Group, concerned with the development of light-weight solar panels, solar collectors, and extendable booms for satellites.

Currently the department has a staff of 600 at its own site and an additional 300 production personnel off-site. Rapid expansion has created a space problem, causing acquisition of 5,000 sq. ft. of trailer space and use of 15,000 sq. ft. of interim structure, in addition to the 108,000 sq. ft. of permanent structures. Further permanent structures are being considered.

According to Iverson, the expansion of business that led to the setting up of the new department did not occur in any particular product line. "It's been a general growth in all areas," he commented. The growth in non-space electronics was almost equally divided between airborne equipment and ground equipment.

• **Analysis prized**—"Probably the thing we are proudest of here is our analytical capability," said Iverson. The department takes up half of the available time on Ryan's IBM 704 computer, which operates on a continuous 24-hour basis. The firm is expecting delivery of an IBM 360 system in April and is also acquiring an EAI 680 hybrid computer.

Among the programs developed is one for landing-radar system analysis. The radar system details, the reflecting surface characteristics, and the vehicle trajectory are inserted into the computer. The program then enables estimation of performance data such as range accuracy, velocity accuracy, and fluctuation noise level.

Another program is used to design phased-array slot-antennas. An antenna of this type might operate at 30 gc, measure 4 in. by 5 in., and generate three beams for velocity measurement and a fourth for altitude measurement. Beam configuration is controlled by the slot positions, which have to be specified to within 0.0002 in. Antennas designed directly on the computer to meet stated requirements have been fabricated. Their performance corresponds closely to requirements, said Iverson.

Other programs developed include calculations of thermal balances in space radars, and satellite orbit determination by means of on-board radar data. These have possible application for *Manned Orbiting Laboratory* radar system design.

The EAI 680 has been procured in connection with development of the Ryan supersonic *Firebee*, but will also be used in satellite work and other areas requiring real-time simulation together with precision computation.

Studies at Ryan have included conceptual design of an X-band lunar surface transponder for guiding the *Apollo* LEM down to a landing site, and analysis of the requirements for an altitude-marking radar for a *Voyager* descent capsule.

• **Two transponder approaches**—The lunar surface transponder was originally considered for use on the *Surveyor* Lunar Rover and was funded as a $1,000 study by the NASA Manned Spacecraft Center. An alternative means of delivery would be on an unmanned *Apollo* mission, as part of the back-up *Apollo* site survey program. A prime requirement was that the transponder should be capable of surviving on the Moon for three years.

Two configurations were studied. One assumed thermal control and power from a delivery spacecraft such as *Surveyor* or the Lunar Rover. The other was a self-contained transponder using a radioisotope thermal generator.

In the self-contained version, the electronics were surrounded by six RTG units on the sides and protected from solar flares by a top plate of 1¼-in.-thick aluminum. The configuration was a 23½-in.-dia. disk with a small antenna mast on top. This mast was made up of an S-Band spiral helix topped by two arrays of X-band crossed dipoles. This gave a capability of communication with the Deep Space Instrumentation Facility, as well as yielding range and bearing information when responding to the LEM rendezvous radar. The X-band beam was concentrated towards the lunar horizon, while the S-band beam was concentrated towards lunar zenith.

In developing other applications of radar systems, Ryan has delivered a small radar unit that extends in front of a hydrofoil craft to measure wave height for control of hydrofoil angle of attack. The radar signal transmitted is amplitude-modulated so that altitudes between 2 ft. and 50 ft. can be measured by a phase-comparison method to an accuracy of 1 in.

The same concept has been used on a similar altimeter that uses infrared radiation. This has since been developed

Sperry To Develop Army Laser Ranging System

An experimental helium-neon CW laser ranging system, directed by a near-infrared passive tracker, will be developed for the U.S. Army by the Sperry Gyroscope Div. of Sperry Rand Corp. at Great Neck, N.Y.

The system will be field tested and evaluated by the Combat Developments Command at Fort Ord, Calif. One system is already in test operation by Sperry.

Designed for use against aircraft, ground vehicles, and personnel, developers stated the instrument already has demonstrated an azimuth and elevation accuracy to better than 10 arc seconds and a range resolution of less than 2.5 ft. at distances from 1,000 ft. to seven miles.

In production. Sperry has firm orders to deliver more than 200 microcircuit computers. Worldwide acceptance of these computers insures immediate availability of replacement parts and service. A MIL-spec, stored-program advance design digital reality, the Mark XIV affords 55,500 operations per second...is light (32 lbs.), small (0.66 cu. ft.)...offers 21 bit word length, 500 kc clock rate, numerous input-output modes, 4,096-word memory core, 16,700 multiplies per second...draws less than 250 w. MTBF is 6,000 hours. Mark XIV meets environmental requirements for MIL-E-5400, MIL-E-16400. Options include increased memory sizes, test and control panel, tape reader input, and special input/output. For details, contact Marketing Mgr. (T-214) *INFORMATION & COMMUNICATIONS DIVISION, Sperry Gyroscope Company, Great Neck, New York.*

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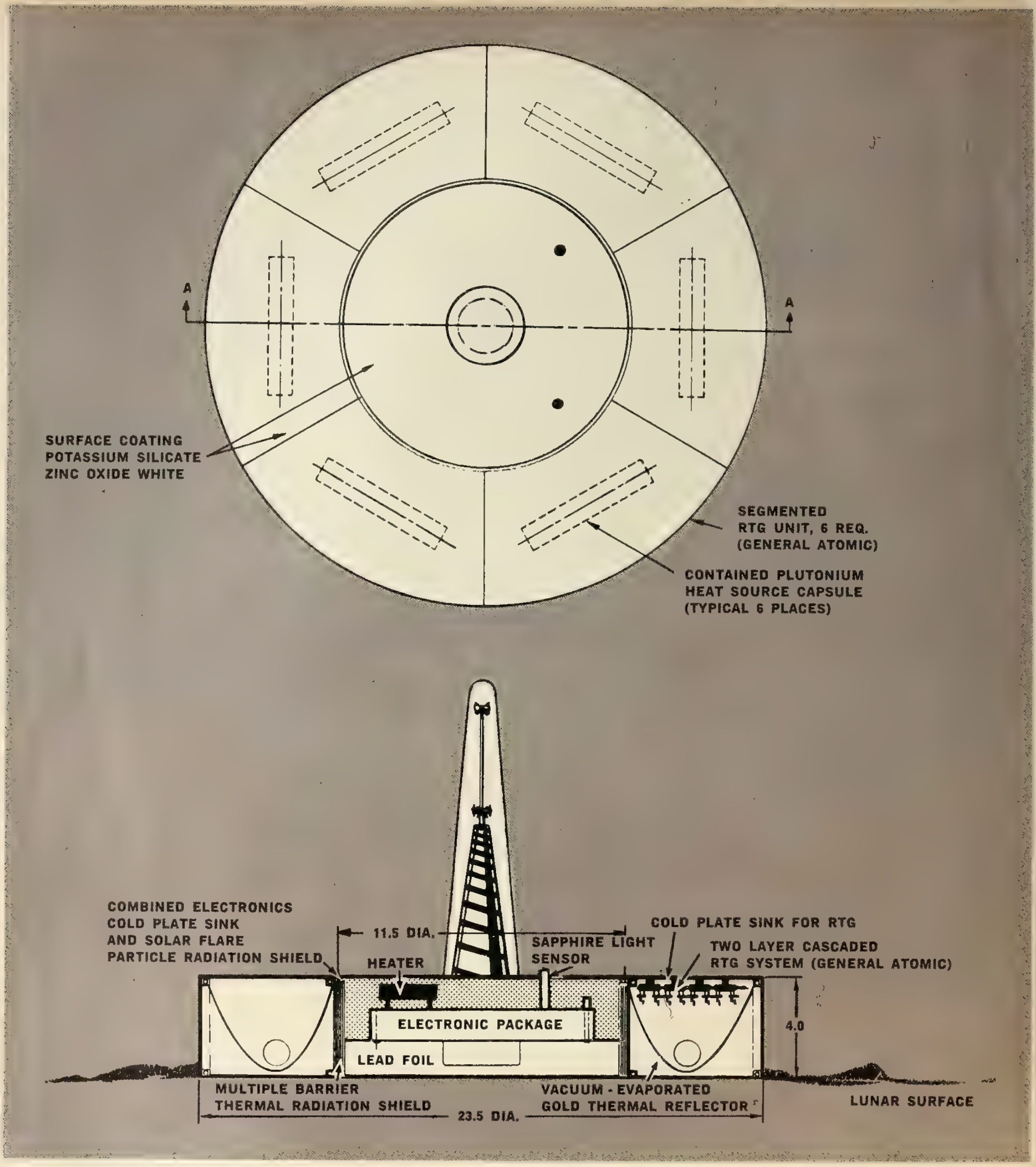

BY USE OF two antenna systems, the lunar surface transponder would guide LEM descent and also communicate with Earth.

An array of crossed X-band dipoles on top of the S-band spiral antenna provides a low-level beam for the LEM rendezvous radar.

into a general-purpose ranging instrument—a small hand-held device that operated initially to ranges of 7 ft. and has since been extended to beyond 100 ft. Its very light weight, low power, and high accuracy suggest possible applications for astronaut-ranging in space or guidance of the blind, or for use as a fusing device for missiles or free-fall bombs.

- **Structures**—In the structures area Ryan has foreseen a market for very large solar-cell arrays requiring an efficient means of packaging and deployment. The department is currently working on a roll-up solar panel (M/R, Nov. 8, p. 40) under contract for Jet Propulsion Laboratory. This panel uses hollow side booms that have considerable rigidity in their natural shape, but are capable of being flattened and rolled up. In current designs the stored energy of the flattened boom is nearly sufficient to deploy it.

Interest has been expressed in use of this type of boom for satellite gravity-gradient stabilization, and a 100-ft. design is likely to be produced in the near future, followed by much longer designs. The satellite booms have a cross-section of about 1 in., in comparison with about 3 in. for the solar panel booms. ■

LAST CHANCE TO FILL UP FOR 48,539,700 MILES

explore Mars, and planets beyond, an will need refueling platforms biting the earth. These orbital fill- stations will store cryogenic fuels that spaceships can rendezvous d take on a tank-full of high en- y propellant.

rmally, large, elaborate facilities needed to store super-cold fuels ch as liquid hydrogen. But now ckheed has developed and tested simple, unique insulation system ich will help man exploit the at efficiency of cryogenic fuels space exploration.

The usual insulation approach has involved dozens of delicate layers of foil and tissue paper contained in a vacuum. These fragile layers have posed extreme handling problems. Using similar materials, Lockheed has solved handling and insulation problems with a technique based on buttoning the layers together. Lockheed's buttoned layers keep minute amounts of heat from leaking into fuel tanks — and they can be handled under factory conditions.

The Lockheed system has passed space chamber tests. It has survived the rigorous environment of countdown and launch at Lockheed's cryogenic flight simulator facility at Santa Cruz, California. These tests have proven that cryogenic fuels can be stored in space — to make possible payloads double and triple those of today.

Insulation systems such as this are just one measure of the technological competence of Lockheed: a corporation dedicated to the conquest of new worlds through innovation.

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TRW SYSTEMS

The Industry Week

Mergers and Acquisitions

Benson Manufacturing Co., the Kansas City, Mo., subsidiary of Electronic Communications, Inc., St. Petersburg, Fla., has merged with its parent company. Benson will become an operating division of ECI. Benson shareholders will receive 1/10 of one share of ECI stock for each share of Benson stock. . . . *Valley Metallurgical Processing Co. will acquire the facilities, inventory and assets of the Magna Div. of Englehard Industries, Inc., Haskell, N.J. Magna produces aluminum, copper and bronze powders and paste. Valley Metallurgical, Essex, Conn., and Stockton, Calif., manufactures spherical aluminum powder for solid-propellant engines.* . . . Leffingwell Chemical Co., Whittier, Calif., has been acquired by a group headed by Richard M. Chewning, former president of Republic Supply Co. of California. The firm will continue manufacture of epoxy adhesives. . . . *Northrop Corp., Beverly Hills, Calif., has purchased 20% of the common stock and 32% of the preference shares of Royal Netherlands Aircraft Factories Fokker for $2.3 million. The purchase was made from RAC Corp., formerly Republic Aviation Corp., Farmingdale, N.Y. In related action, RAC stockholders met Nov. 19 and approved a plan to liquidate the firm's corporate shell (M/R, Nov. 22, p. 37).* . . . American Electronic Laboratories, Inc., Colmar, Pa., has purchased Electromagnetic Technology Corp., Palo Alto, Calif. AEL produces communications equipment. ETC manufactures microwave filters.

New Activities

ITT Corp., Paramus, N.J., has formed ITT Data Services Div. to provide data-processing services for government and industry. Robert A. Leonard has been named executive vice president and general manager. . . . *42 Corp. has been formed in San Diego, Calif., for engineering and manufacturing work in the aerospace and electronics industries. J. W. White, head of the founder group, announced projected sales exceeding $10 million. The firm is also negotiating six new acquisitions, White said.* . . . Electro-Optical Systems, Inc., Pasadena, Calif., has divided its Ion Physics Dept. into two separate units. The Ion Technology Dept. will be headed by Marshall P. Ernstene; the Gaseous Electronics Dept. will be managed by Robert C. Speiser. Both are part of EOS's Fluid Physics Div. . . . *Aero Systems Associates has been formed in Cold Spring Harbor, N.Y., to provide services in aeronautical systems analysis and development. Albert W. Blackburn is head of the new firm.*

International

Ferranti Ltd., Oldham, Lancs., England, manufacturer of parametric amplifiers, has based a microwave sales engineer in Plainview, N.Y. The move is part of a plan to expand Ferranti's field of operation to include the United States. . . . *All-State Welding Alloys Co., Inc., White Plains, N.Y., is opening a subsidiary company in St. Niklaas-Waas, Belgium. The firm will serve distributors throughout the Common Market. General manager is George Bogaerts.* . . . Oak Electro/Netics Corp., Crystal Lake, Ill., has acquired full control of N. V. Messa Electronics, Emmen, Holland. Oak had purchased 75% stock interest in Messa last April. The company, which produces antennas, couplings and impedance transformers and filters, will be operated as a wholly owned subsidiary of Oak.

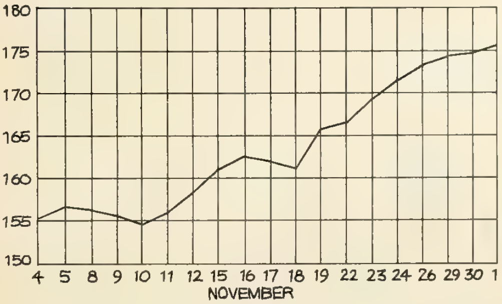
Facility Expansions

Fairchild Hiller Corp. has named the George Hyman Construction Co., Washington, D.C., to build four buildings and related site work at the Sherman Fairchild Technology Center near Germantown, Md. Buildings are expected to be completed in late summer of 1966. Cost of the initial phase of the program is approximately $4 million. . . . *General Aniline & Film Corp. plans to construct a $1-million experimental film-coating laboratory and pilot plant at its research laboratory near Binghamton, N.Y. Completion is scheduled for early 1967.* . . . Corning Glass Works' Fluidic Products Dept. is being moved from Bradford, Pa., to larger facilities in Corning, N.Y. . . . *Union Carbide Corp.'s Carbon Products Div. will build a plant in Greenville, S.C., for manufacture of Thornel graphite yarn. The filament is considered an ideal reinforcing agent for matrix composites used in aerospace, hydrospace and aircraft structures.*

Engineering Employment Up at Philco

Philco Corp.'s Aeronutronic Div., Newport Beach, Calif., has announced a 20% rise in engineering employment in the past 60 days. The increase is part of a planned growth of the division, a spokesman said, and hiring will continue at a moderate rate in the immediate future.

Missile/Space Stock Index



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contracts

AIR FORCE

$6,680,319—**Applied Technology, Inc.,** Palo Alto, Calif., for aircraft electronics equipment.

$6,500,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for *Agena* rocket launch services.

$1,774,365—**Northrop Corp.,** Norair Div., Hawthorne, Calif., for installation, operation and maintenance of a *Bomarc* missile training facility at Vandenberg AFB, Calif.

$1,523,085—**Sperry Rand Corp.,** New York, N.Y., for production of compass components and $1,150,000 to Sperry Gyroscope Co., Great Neck, N.Y., to continue work on countermeasure equipment.

$1,455,711—**North American Aviation, Inc.,** for studies applicable to an advanced manned strategic aircraft.

$1,300,000—**Chicago Aerial Industries, Inc.,** Barrington, Ill., for aerial-reconnaissance cameras.

$325,000—**Radio Corp. of America,** Missile & Surface Radar Div., Moorestown, N.J., for engineering services in connection with BMEWS program.

$196,000—**Cornell Aeronautical Laboratory, Inc.,** Buffalo, N.Y., for investigation of advanced sensor techniques for terrain following vehicles.

$71,990—**United States Testing Co.,** Hoboken, N.J., for inspection certification service, Kennedy Space Center, and Cape Kennedy Air Force Station.

$49,000—**Litton Systems, Inc.,** Applied Sciences Div., St. Paul, Minn., for study of the dissemination characteristics of encapsulated particles.

ARMY

$12,674,886—**Hughes Aircraft Co.,** Culver City, Calif., for research and development work on an anti-tank missile.

$7,461,073—**Raytheon Co.,** Lexington, Mass., to produce mortar fuzes.

$3,715,425—**Sylvania Electric Products, Inc.,** New York, N.Y., first segment of a $5,352,300 award to make electron tubes in Emporium, Pa.

$1,967,878—**Avco Corp.,** Everett, Mass., modification for research program under Project Defender.

$1,800,000—**Radio Corp. of America,** Missile & Surface Radar Div., Moorestown, N.J., an increase in contract for a classified program.

$1,500,000—**Radio Corp. of America,** Aerospace Systems Div., Burlington, Mass., an increase for the MTE program.

$1,497,000—**Varian Associates,** Palo Alto, Calif., for klystron tubes to be used in a missile system.

$1,422,203—**Martin Marietta Corp.,** Friendship Airport, Md., to manufacture special support equipment and spare parts for radio transmitters.

$1,345,408—**Belock Instrument Corp.,** College Point, N.Y., to make maintenance equipment for the *Hawk* air defense missile.

$1,200,000—**Philco Corp.,** Philadelphia, Pa., for continued industrial-engineering work on the *Shillelagh* anti-tank missile.

$101,725—**Raytheon Co.,** Andover, Mass., for field installation of modification kits for the *Hawk* missile system; $48,330 for replenishment repair parts for the *Hawk* missile system; $419,841, $299,217 and $81,190 for repair parts for the *Hawk* missile system; $402,676 for retrofit kit for the *Hawk* missile system, and $71,519 for reconditioning of assemblies for the *Hawk* missile system.

$99,086—**Radio Corp. of America,** Aerospace Systems Div., Burlington, Mass., for design plan and exploratory development model of intensified vidicon TV camera.

$72,529—**Philco Corp.,** Aeronutronic Div., Newport Beach, Calif., for range safety modification number two from the *Nike-X* Project Office.

$52,500—**Lockheed Propulsion Co.,** Redlands, Calif., for Hughes H26A rocket motor.

NAVY

$8,794,434—**General Precision, Inc.,** Tarrytown, N.Y., to manufacture components for the *Subroc* missile in Glendale, Calif.

$2,575,800—**General Instrument Corp.,** Hicksville, N.Y. to make classified electronic equipment.

$2,000,000—**Aerojet-General Corp.,** Von Karman Center, Azusa, Calif., supplemental agreement to a $62,000,000 contract to build a number of advanced Mod 1 torpedoes.

$1,760,000—**Columbia University,** New York, N.Y., for additional research under Project Artemis.

$1,506,810—**North American Aviation, Inc.,** El Segundo, Calif., to make classified electronic equipment.

$627,500—**Varo, Inc.,** Garland, Tex., for additional aircraft missile launchers.

NASA

$75,800,000—**North American Aviation, Inc.,** Rocketdyne Div., Canoga Park, Calif., to produce 48 additional J-2 rocket engines.

$1,399,500—**Akwa-Downey Construction Co.,** Milwaukee, Wis., for instrumentation and communication cables for LC-39 phase two, Kennedy Space Center.

$300,000—**Radio Corp. of America,** Astro-Electronics Div., Princeton, N.J., an increase in contract for high-data-rate storage system.

$244,359—**Documentation, Inc.,** Bethesda, Md., for development and implementation of electronic computer programs.

$50,000—**Avco Corp.,** Research and Advanced Development Div., Wilmington, Mass., from Goddard Space Flight Center, one-year renewal contract to study contaminating effects of space environment on optical materials similar to those used on *Tiros* and *Nimbus* weather satellites.

INDUSTRY

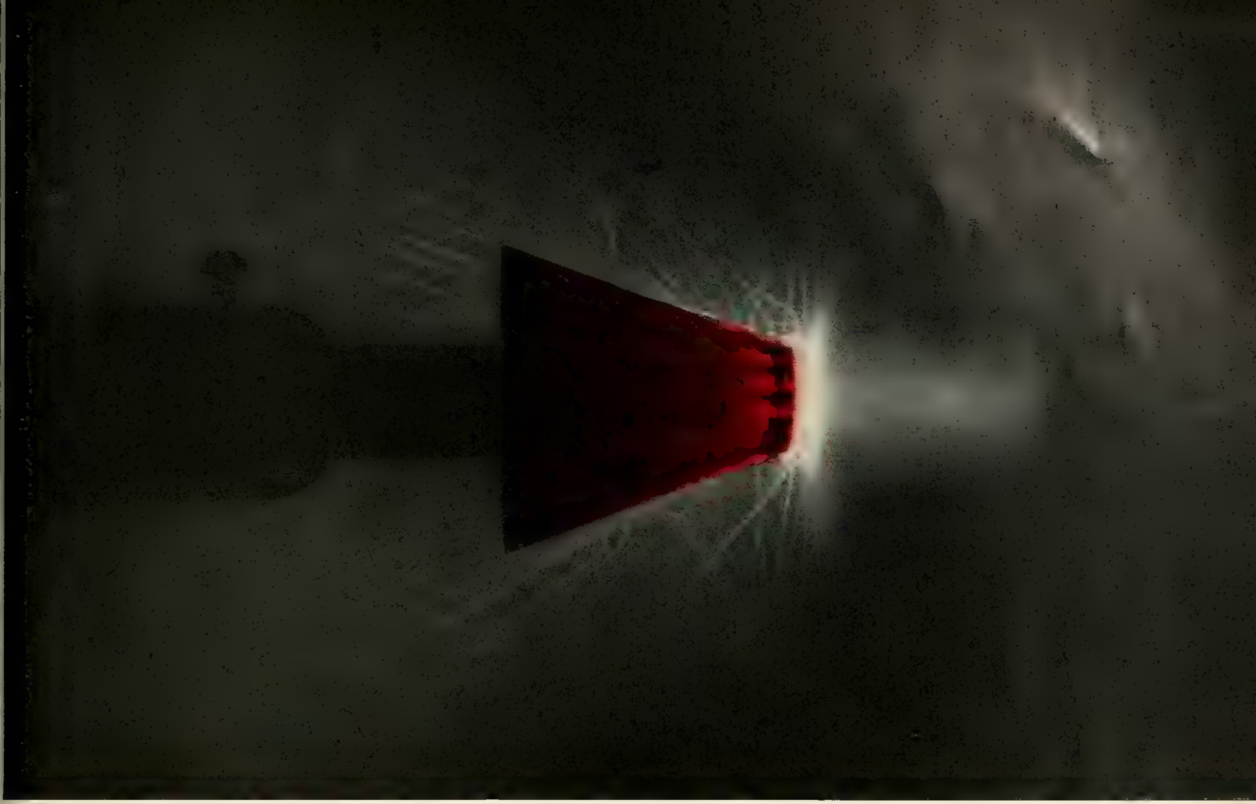
$4,000,000—**General Precision, Inc.,** Link Group, Binghamton, N.Y., from **General Dynamics,** Fort Worth Div., Fort Worth, Tex., for flight and mission simulator.

$3,000,000—**Raytheon Co.,** Lexington, Mass., and CSF-Compagnie Generale de Telegraphie Sans Fils of Paris, to design and construct a cyclotron for use in nuclear research at the University of Maryland, College Park, Md.

COMMUNICATIONS SATELLITE CORP.

$11,700,000—**Hughes Aircraft Co.,** Culver City, Calif., to build four new satellites.

$909,382—**Vern W. Johnson & Sons, Inc.,** Spokane, Wash., for site preparation and construction of buildings and other facilities for Comsat's fixed Earth station at Brewster Flat, Wash.



NEW G-E RTV SILICONE RUBBER MAKES BETTER HEAT SHIELDS

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...In space environmental exposures down to −300°F

Re-entry conditions from 3 to 1200 BTU/ft.^{2}-sec and exposures in the spatial environments to temperatures down to −300° F demonstrate that General Electric's new methyl-phenyl RTV silicone rubbers are by far the best available as heat shields in non-ballistic entry vehicles. Other prime applications are case insulation for solid fueled rocket motors and insulation for launching pads.

G-E methyl-phenyl RTV's are room-temperature vulcanizing. This means you can custom-compound your own formulations. You can cast them in place, foam them in place, add fibrous and/or low density fillers, or foam in honeycomb form.

Simulated space exposure tests have demonstrated that thermal shields based on the G-E methyl-phenyl materials retain structural integrity at temperatures down to −300° F. Other materials fail at substantially less extreme temperatures.

One aerospace engineering group reports that shields formulated from G-E methyl-phenyl silicones also retain adhesion at temperatures up to 600° F under soak conditions, and as high as 1000° F under transient conditions. Lighter, thinner heat shields are indicated.

Prove to yourself that these new G-E methyl-phenyl RTV's do all the things above, resist more severe thermal cycling and possess better processability to meet your requirements. (Even if you do not use a G-E methyl-phenyl compound in your heat shield construction, you would do well to consider it as your adhesive.) Fill in the coupon for a free sample and further data.

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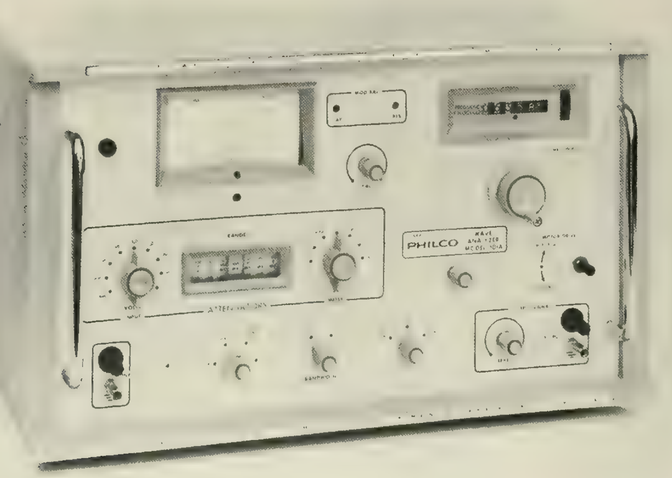

New Product of the Week: Wave Analyzer

A solid-state, wide-range wave analyzer with digital readout has been developed by Philco Corp.'s Communications and Electronics Div.

The Model 301A permits the user to examine fundamental frequencies, harmonics and other components of any signal in the range of 20 cps to 100 kc. Frequency resolution is specified as ± (1% + 10 cps) from 20 cps to 10 kc, and ± 100 cps from 10 to 100 kc.

The five-digit readout provides numerical values in 10-cps increments with 2-cps interpolation marks. A tuner motor drives the instrument across the full frequency range of 20 cps to 100 kc in approximately 35 seconds.

As a voltmeter with restored signal at the output (identical in frequency with the input signal), the 301A provides a filter effect to isolate one signal out of a group, or a signal partly masked by noise, and amplifies it for greater resolution and measurement accuracy.

Full-scale voltage ranges cover from 30 mv to 300 v. The instrument reads dbm directly on 600-ohm circuits at full-scale levels from 50 to —90 dbm with ± 0.5-db accuracy, according to the company.

Circle No. 151 on Subscriber Service Card

Transistor-Y-Meter

Rohde & Schwarz has developed a solid-state transistor-Y-meter for measurement of dynamic and static parameters of PNP/NPN transistors and semiconductor diodes.

The type TYM operates at eight switch- selected test frequencies between 20 Khz and 37 Mhz.

In operation, the meter determines the RF measurement of the four-pole small-signal y-parameter of both PNP and NPN transistors in a common-emitter circuit. It indicates complex components of the y-parameters and, in the case of forward transfer admittance, it measures the modulus.

The unit is operable over a range of 0 to 100v and 0.1 to 100 ma. Static parameters are measured with an accuracy of ± 3%; limit of error in dynamic measurement is ± 10%.

Circle No. 152 on Subscriber Service Card

Servo Motor-Generator

Varo, Inc.'s Electrokinetics Div. is marketing the Model 20023 a-c servo motor and velocity feedback generator.

The unit was custom-designed to serve as a drive unit for the azimuth drive actuator in the *Pershing* missile transporter-erector-launcher and meets MIL-E-5272, MIL-STD-202 and MIL-I-26600 specifications.

The 115-v servo motor-generator is designed with one fixed voltage phase and one variable voltage phase. Key features include: a two-phase, 400-cps motor with speeds ranging from 10,300 to 11,750 rpm and maximum operating torque of 1.20 in/oz.; and a generator with output voltage of 0.20v ± 10% at 1,000 rpm and a pulse linearity of ± ½% at 0 and 3,000 rpm.

Circle No. 153 on Subscriber Service Card

C-Series Resistors

Five precision metal film resistor styles are available in power ratings from 1/20th watt to 1/8th watt at 125°C from Angstrom Precision, Inc.

Resistance ranges from 24.9 ohms to 500 k are available in tolerances down to ± 0.1%. The process provides for inherent temperature coefficient better than ± 25 ppm/°C, although ± 50 ppm and ± 100 ppm characteristics are available.

The resistors are processed in accordance with NPC-200-3 and MIL-R-10509. Weldable leads per MIL-STD-1276, type D, N-1 and N-2 are available.

Circle No. 154 on Subscriber Service Card

Microwave Antenna

A four-port antenna for use in dual-band systems operating in the 5.9-6.4 and 10.7-11.7 gc bands, has been developed by Andrew Corp.

The device has dual polarized inputs for each frequency band, eliminating the need for a frequency combiner. A real physical feed (11 gc) is superimposed coincidental to a virtual feed (6 gc) to operate like a "space filter." The feed consists of a Gregorian telescope configuration at 6 gc and a circular waveguide buttonhook at 11 gc, both using a common 10-ft.-dia. paraboloidal reflector.

The antenna has a gain of 42.0 dbi at 6.125 gc and 47.2 dbi at 11.2 gc. Minimum isolation between any two ports is 30 db.

Circle No. 155 on Subscriber Service Card

Ionization Tube

A bakeable, exposed ionization tube, designed for easy replacement of burned-out filaments, grid and collector, has been announced by Consolidated Vacuum Corp.

The Model GIC-018 can be used in high and ultra-high vacuum systems down to 2 x 2^{-10} torr. It is available in three separate flange-mounted styles, all bakeable to 450°C. Each tube will operate with any CVC hot-filament ionization gauge power supply with ratings equivalent to the GIC-017 tube.

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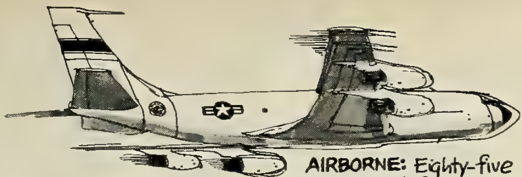
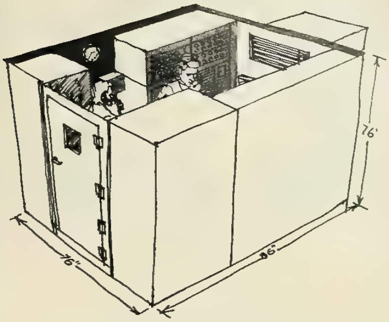
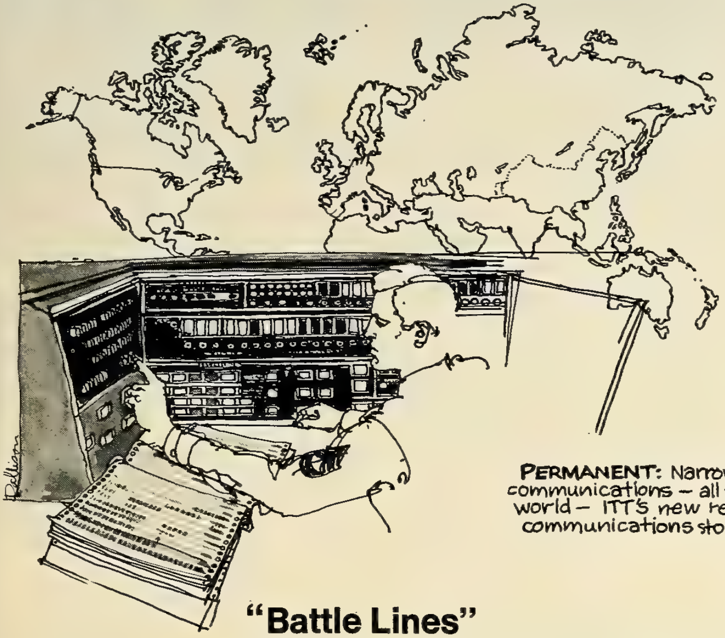


AIRBORNE: Eighty-five line flying switchboard for airborne command centers. Direct connection to radio and multiplex, even 24-party conferences.



TRANSPORTABLE: One hundred lines with automatic dial are contained within this compact, solid-state switchboard for tactical areas.



PERMANENT: Narrow- and broad-band communications – all types – to and from anywhere in the world – ITT's new reed relay system and communications store and forward processor.

"Battle Lines"

In this age, the vital battle lines can be the lines through which you communicate.

Wherever you have a need – up in the air, out in the jungle, around the world – there is an ITT switching system tailored to do the job.

If your problem is massive worldwide communications, all kinds, flowing in and out of a fixed command control facility, ITT's new reed relay switching system can handle it.

Flexible? This technique offers voice, teleprinter, video, card handling, paper and magnetic tape or computer-to-computer communications.

Reliable? Scientists estimate each reed relay's life is more than 10^9 operations. That's reliability you can count on.

Versatile? Enough for the most complex jobs. Western Union is now installing ITT reed relay systems in the GSA Advanced Record System. These switching techniques will be used to tie in 1600 data stations throughout the United States. It's also on order for the Canadian broad-band switching network.

When mobility is a must, there's an entire family of solid-state switchboards: 4-wire tactical units with 40, 100 or 300 lines; a 1000-line 12′ x 8′ switchboard that moves by truck or helicopter to remote sites; an airborne electronic telephone central office that provides automatic switching for air-to-air and air-to-ground calls.

Complete systems are also within ITT's sphere. Witness ACE HIGH, ETA, EUR-MED and PACSCAT tropo systems for which ITT companies served as prime contractor and supplier.

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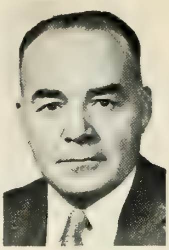
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FRIES

John J. Smith: Appointed director of engineering for the Data Recorders Div., Consolidated Electrodynamics Corp. For the past two years, he has been assistant director of engineering for the division.

Herbert I. Miller: Appointed division vice president, defense planning and regional offices, Radio Corp. of America's Defense Electronic Products. He will have overall responsibility for RCA's five defense regional offices.

John C. Borden: Appointed executive vice president of Cutler-Hammer, Inc. In addition to the firm's financial affairs, he directs the legal, personnel, tax and purchasing activities.

Dr. Joseph Saloom: Elected vice president, Tube Group Eastern Operations, Varian Associates. **Mr. Thomas Sege:** Elected vice president, Eimac Div.

Raymond S. Fries: Elected vice president, manufacturing, of Varian Associates. He will have overall responsibility for Varian's manufacturing activities throughout the U.S., Canada and Europe.

Arnold P. Moran: Elected senior vice president of U.S. Industries, Inc. He will be in charge of the treasurer's, controller's and legal departments. **Clarence J. Plisky** has been elected senior vice president in charge of manufacturing, engineering and facility acquisitions.

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System vulnerability analysis, including analytical and experimental activities involving: Radiation Effects Testing, Radiation Transport and Damage; Solid Mechanics, Nuclear Weapons Effects Testing, and the application of computer techniques to these areas.

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Robert F. Reese: Named director of engineering for the Tech Rep Div. of Philco Corp. **T. J. Heckelman** was named director of planning and development.

William W. Swenson: Appointed manager of the Houston, Tex., field office of Textron's Bell Aerosystems Co.

Linus M. Raring: Named director of research of the Fansteel Metallurgical Corp. **Dr. David K. Priest** was appointed director of development and engineering. **Dr. Donald R. Mash** has been appointed manager, applied physical metallurgy laboratory, reporting to Dr. Priest.

Dr. G. F. Taylor: Named assistant general manager of the Houston Aerospace Systems Div. of Lockheed Electronics Co. He is directing a computer programming and operations project under a NASA contract.

George P. Irwin: Named director of manufacturing for the Middletown Div. of Aeronca Manufacturing Corp. He will be responsible for all manufacturing activity for the division.

Lucius A. Perry: Appointed manager of launch operations at Bendix Corp.'s Kennedy Space Center staff. **John R. Carden:** Named manager of program planning.

George F. Nahill: Appointed research manager for Taylor Corp.'s reinforced plastic products. He will direct the development of plastic products for industrial applications.

J. S. Parker: Elected chairman of the board of the Aerospace Industries Association. He is vice president and group executive, Aerospace and Defense Group, General Electric Co.

W. O. Mergenthal: Appointed vice president of NSC International, Inc. He has been with the company since 1962, previously serving as director of the West Coast Div. and director of the Engineering Div.

Jules I. Schwartz: Appointed director of technology at System Development Corp. He will be responsible for the technology directorate's program of applied research and development in the information sciences.

missiles and rockets
THE WEEKLY OF ADVANCED TECHNOLOGY

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American Institute of Chemical Engineers 58th Annual Meeting, sponsored by The American Institute of Chemical Engineers, Bellevue Stratford Hotel, Philadelphia, Dec. 6-10.

Eighth Annual Army Aviation Contract Services Symposium, sponsored by the National Aerospace Services Association, Statler-Hilton Hotel, Washington, D.C., Dec. 6.

NSIA/AFSC Microelectronics Conference on "Applications of Microelectronics Technology," sponsored by the National Security Industrial Association and the Air Force Systems Command, Sheraton-Park Hotel, Washington, D.C., Dec. 8-9.

National Defense Transportation Association's Regional Defense Transportation Conference, sponsored by the National Defense Transportation Association, New York Hilton Hotel, New York City, Dec. 9.

American Association for the Advancement of Science 132nd Annual Meeting, sponsored by the American Association for the Advancement of Science, University of Calif., Berkeley, Dec. 26-31.

National Society of Professional Engineers Winter Meeting, sponsored by the National Society of Professional Engineers, Americana Hotel, Miami Beach, Fla., Jan. 5-8.

American Chemical Society National Winter Meeting, sponsored by the American Chemical Society, Phoenix, Ariz., Jan. 16-21.

Third Coral Gables Conference on Symmetry Principles at High Energy, sponsored by the University of Miami, Air Force Office of Scientific Research, Atomic Energy Commission, National Aeronautics & Space Administration, National Science Foundation, and Office of Naval Research, University of Miami, Coral Gables, Fla., Jan. 20-22.

Society of Plastics Engineers Regional Technology Conference, sponsored by the Society of Plastics Engineers, Cleveland Section, Sheraton-Cleveland Hotel, Cleveland, Jan. 20.

Third Aerospace Sciences Meeting, sponsored by the American Institute of Aeronautics & Astronautics, New York City, Jan. 24-26.

Symposium on Electrification of Machinery, sponsored by the Institute of Electrical & Electronics Engineers, Worcester Section, Wachesett Country Club, West Boylston, Mass., Jan. 25.

Engineering & Operations Workshop, sponsored by the American Public Power Association, Roosevelt Hotel, New Orleans, La., Jan. 25-28.

1966 Annual Symposium on Reliability, cosponsored by the American Society for Quality Control, Institute of Electrical and Electronics Engineers, Reliability Group, the Institute of Environmental Sciences, and the Society for Nondestructive Testing, Sheraton-Palace Hotel, San Francisco, Calif., Jan. 25-27.

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The Hogwash Conference

AMERICAN AND SOVIET scientists get together at fairly frequent intervals to discuss disarmament problems in an international forum known as the Pugwash Conference.

Last week, without benefit of Soviet participation but with some of the same U.S. scientists in attendance, a so-called blue ribbon panel on arms control reported to a Presidentially convened White House Conference on International Cooperation held in Washington.

The recommendations of this supposedly objective group were hardly surprising. The panel was chaired by Dr. Jerome B. Wiesner, former science assistant to the President who has displayed in the past a far better grasp of science than of the realities of international politics. One of the prominent members was former Under Secretary of Defense Roswell Gilpatric, already so publicly identified with a nonsensical program of disarmament as to erase any possibility of objectivity.

Of the six government consultants to the panel, four are employed by the Arms Control and Disarmament Agency. A fifth was Mr. Arthur Barber, Deputy Assistant Secretary of Defense, who makes a career of disarmament speeches.

If this Hogwash Conference has any effect on the defense policies of this nation, then heaven protect us.

The disarmament proposal from the panel which has attracted the most attention is a recommendation for a three-year moratorium on deployment of ballistic missile defensive systems. The committee's reasons for this certainly are worthy of close examination.

"First of all," says the panel report, "there remains the basic question of the military value of the system. Here many technical questions remain to be answered." Dr. Wiesner expressed his personal doubt at the meeting that *Nike-X* could meet the requirements of even the most favorable combat situation contemplated for it.

The fact is that it is generally agreed throughout the Dept. of Defense that *Nike-X* now is technically ready for deployment.

The panel quotes Secretary McNamara's testimony to Congress early this year on technical problems of *Nike-X* but ignores later developments.

It also conveniently fails to quote testimony from Mr. McNamara and other DOD officials to the effect that a $25-billion ABM and shelter program might save as many as 80 million U.S. lives in a nuclear attack.

The real gist of the committee's argument is contained in this statement: "The Panel believes that the United States has not given the political consequences of the ABM deployment sufficient thought and certainly has not yet explored the ways in which the U.S. and the USSR could avoid unintended effects of the systems on the other's deterrent force."

It adds: "We also believe that the political posture of the Soviet Union is delicately poised at the moment; it is very clearly in the U.S. interest to avoid such actions as might deflect the Soviet Government from a course of improving its relations with the West."

We humbly suggest to the committee that the best interests of the U.S. lie in protecting itself, not in worrying about the effect of such protection on Soviet policy, of which the committee knows nothing.

"And in three years' time," continues the panel report, "it may be possible, not only to see more clearly what strategic threat the People's Republic of China will and will not soon present, but also what the response of both the United States and Soviet Union should be."

We shall ignore the happy assumption that the U.S. and USSR are bosom buddies in alliance against the heathen Chinese and comment only that what we are most likely to see in three years is a Soviet antiballistic missile defense.

If the Soviet Union meanwhile heads off a U.S. ABM by convincing a bunch of addle-pated dreamers that the U.S. should tiptoe around such a project for fear of unsettling some mythical balance of power, then it has indeed pulled off a coup. Comrade, it is to laugh.

MUCH OF U.S. POLICY of late seems to be based on a belief that the Soviet Union is willing to accept an inferior status in regard to the number of offensive intercontinental missiles deployed. Just where this naive assumption came from is unclear. There is no question of present U.S. superiority in ICBM's. But we fail to recall any Russian stating that the Soviet Union will continue to accept this. To the contrary, indications are that the Soviets are making every effort to close the gap.

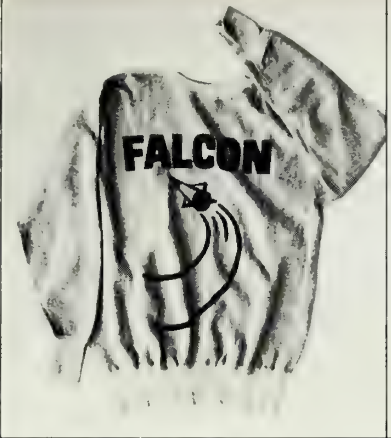
We do not understand reasoning which declares that it is U.S. deployment of an ABM which will bestir the Soviets into increasing their offensive missile force. We may be fools, but it is dangerous to assume that the Russians are also.

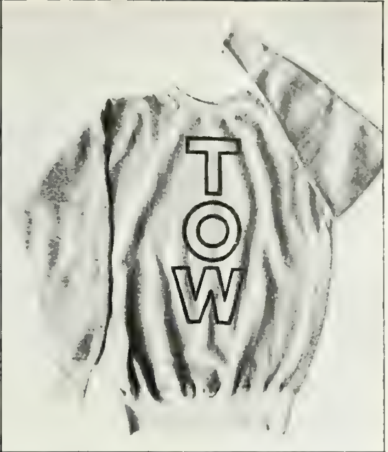
The worst aspect of such a White House-inspired report is, of course, that it will be accepted by the gullible. As if to prove this fact, two such candidates immediately stepped forward—the *New York Times* and the *Washington Post.* Both have backed the panel proposal for a three-year ABM moratorium. The *Times* notes that ABM deployment would set off a dangerous new Soviet-American nuclear missile race. The *Post* declares that deployment of ABM systems by either nation "would almost certainly induce both superpowers to step up their strategic weapon programs in an effort to insure their respective 'deterrent' capabilities."

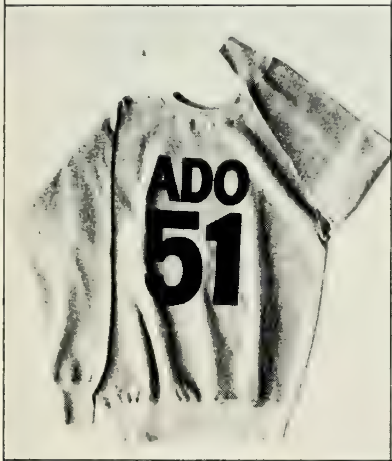
Hogwash, apparently, is contagious.

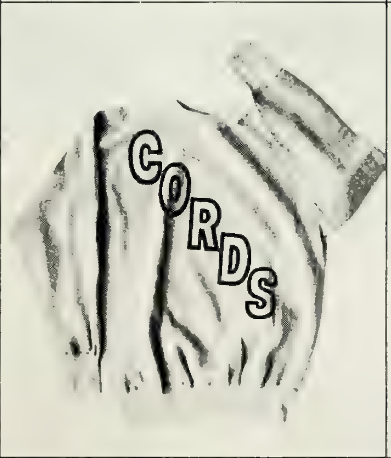
William J. Coughlin

PICK YOUR TEAM









Hughes Aeronautical Systems Division, active with many major contracts such as CORDS, TOW, PHOENIX, WALLEYE, and other advanced airborne weapon systems, has dozens of openings for graduate Engineers.

Desired background should include: familiarity with airborne missile and fire control systems and the associated AGE and maintenance equipment; the definition of test equipment requirements; the development of integration testing; thorough academic preparation in control systems, electronic circuits, analog and digital computers and advanced mathematics or a familiarity with airborne pulse radar and pulse doppler fire control.

All openings require a B.S. or advanced degree in EE or Physics, a minimum of three years of related professional experience and U.S. citizenship.

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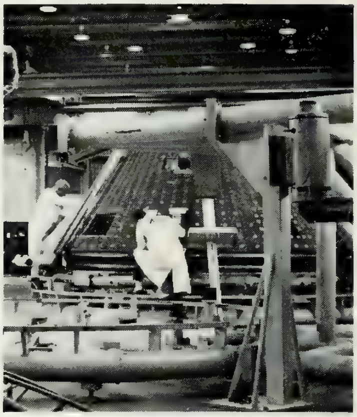

The ablative heat shield for the Apollo Command Module consists of a phenolic epoxy resin material supported by a fiberglass honeycomb matrix. Avco/RAD developed special guns to inject the material, at the proper temperature, into more than 370,000 individual cells in the honeycomb. After X-ray testing is performed to assure that no voids exist, the heat shield is baked in huge ovens. Because maximum temperatures across the surface of the Command Module will vary during atmospheric re-entry, and weight limitations are severe, the heat shield must be contoured to precise thicknesses... meeting the varying ablation requirements. Giant lathes, controlled by computer-generated tapes, provide the necessary accuracy, beyond the reach of even the most skilled human operator. Such specialized fabrication techniques comprise just one of our capabilities in systems analysis, research, engineering, manufacturing, flight testing and over-all program management. Avco/RAD puts all these capabilities together "under one roof."

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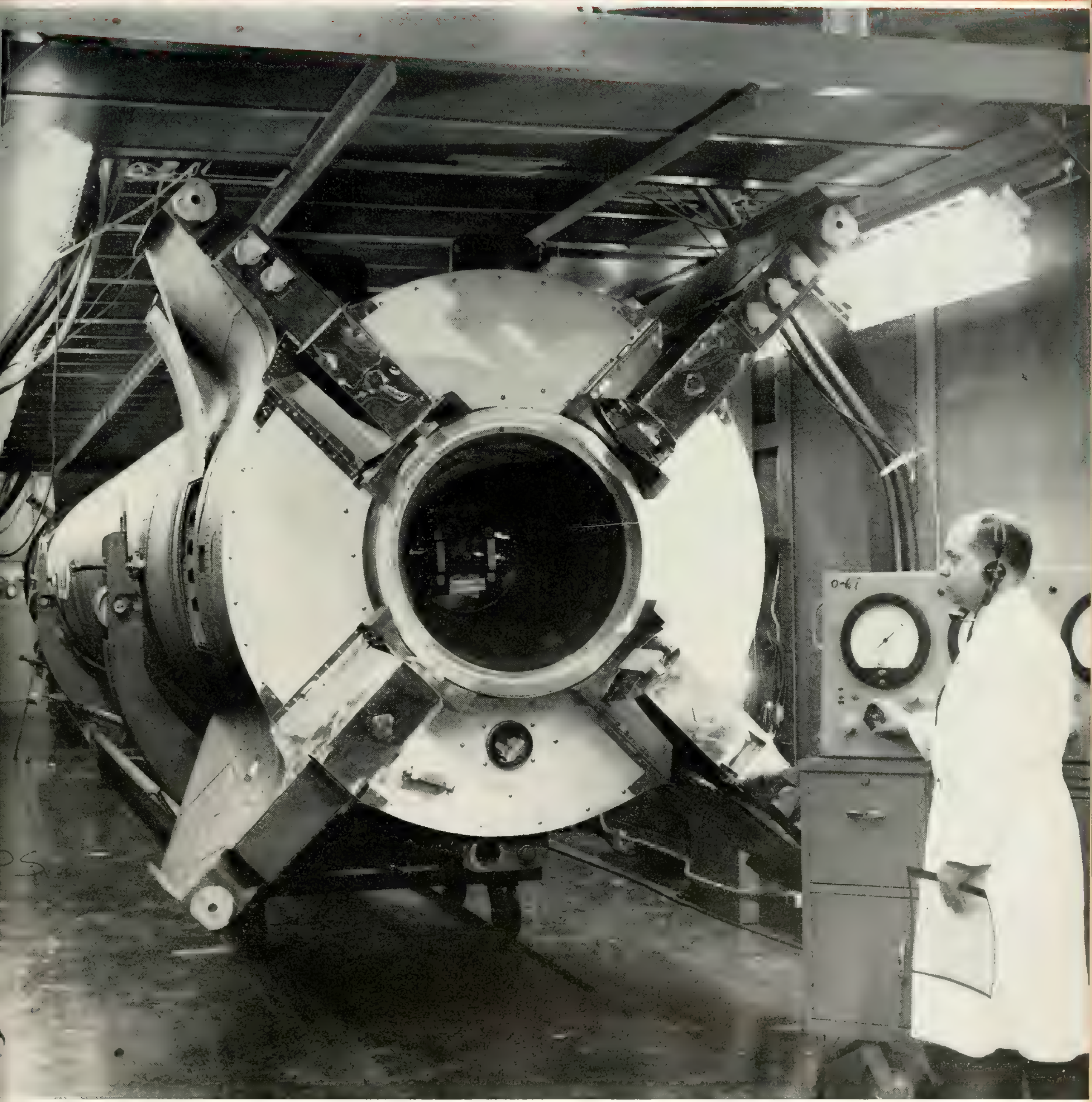
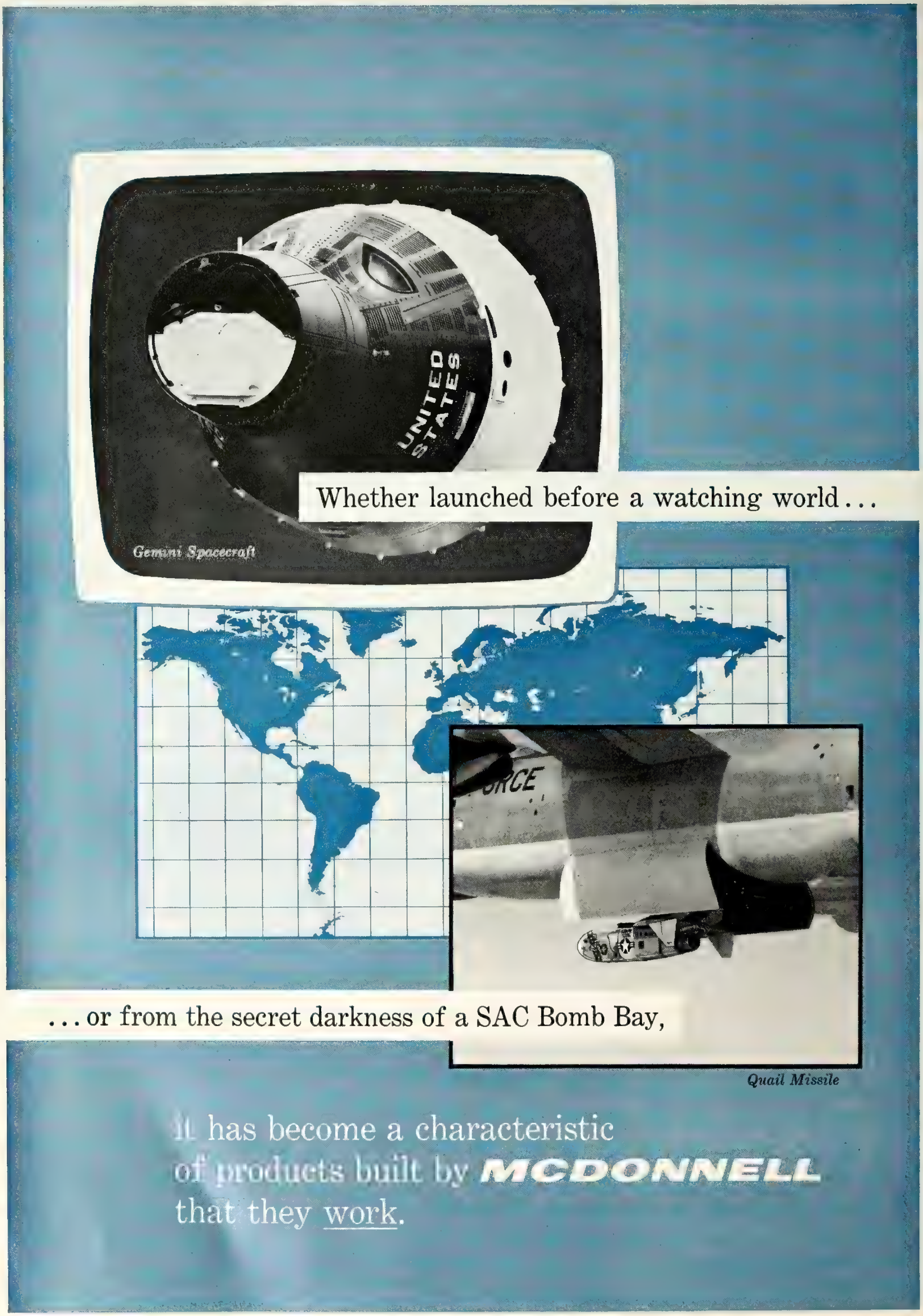


Redstone Target Vehicle Gets Pressure Check

NASA Ponders Gemini 8 Speedup

Redstones Used as Missile Targets

Multipurpose Manned Vehicle Urged



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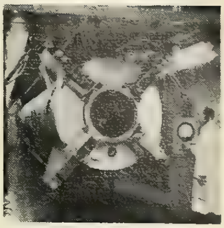
THE COVER



Part of the Redstone modification work being done by Chrysler for the Army Missile Command is to pressure-check the booster unit for air leakage in this enclosed cage. Test assures that joints are sealed and valves functioning. Navy, ARPA are using Redstone as target. See p. 16.

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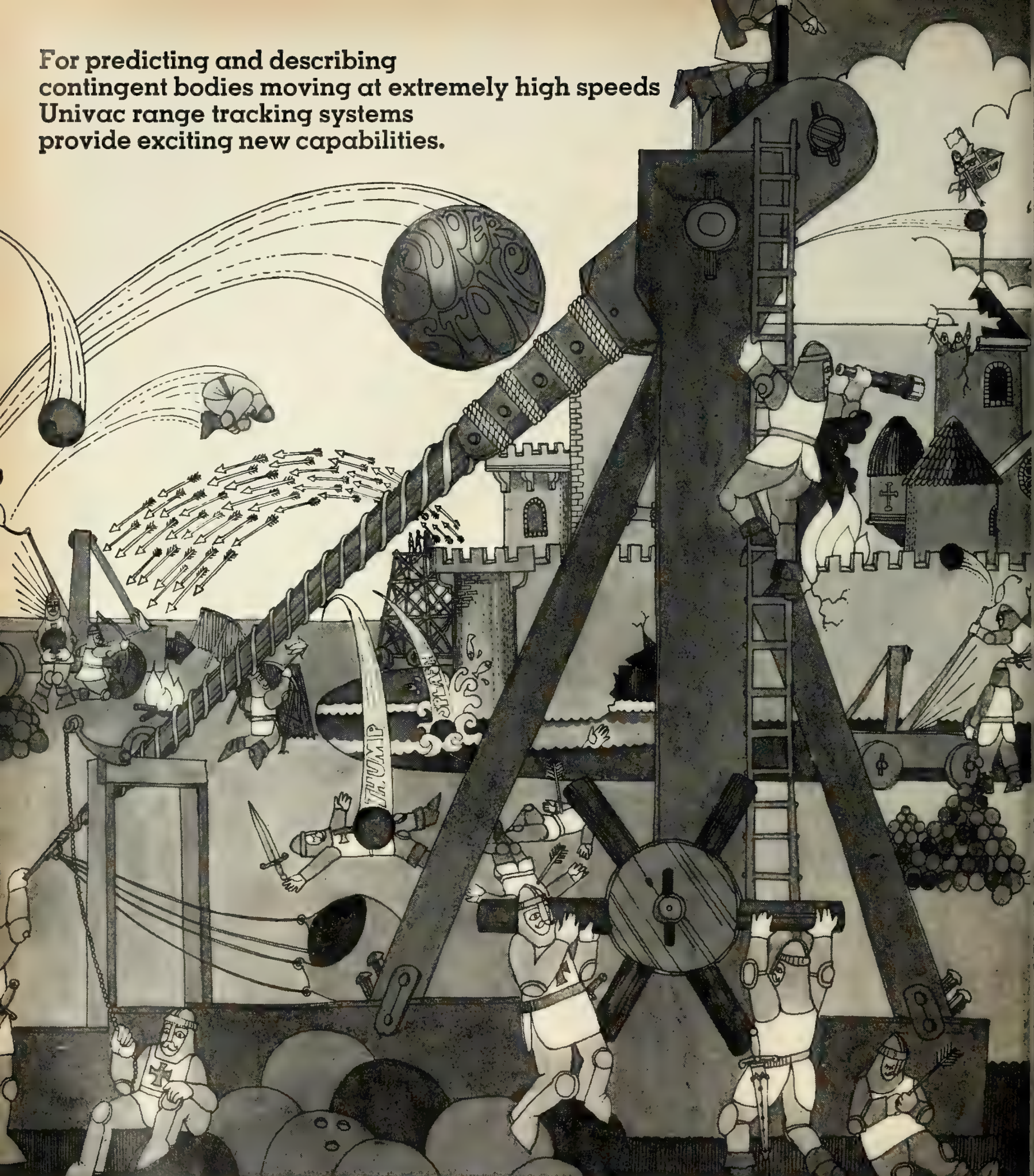

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letters

Warping the Isoclines

To the Editor:

We immensely enjoyed Harry Bricker Fuchs' humorous interpretation (Letters, M/R, Nov. 22, p. 6) of the Heisenberg uncertainty principle and his use of the same to explain the failure of *Luna 7* to soft-land on the Moon. We feel, however, that there are one or two points which Mr. Fuchs overlooked.

It would seem that Mr. Fuchs' concern that "the lack of resonance inherent in the interference of the time constant of the U.S. space program will result in an undesirable variant in time" would be less great had he considered the adiabatic entropy reversal which accompanies "changes in the state or phase of electrons," cancelling out the "storm-time variations" which Mr. Fuchs asserted would prevent correct timing for firing retrorockets.

Another explanation for *Luna 7's* failure, which Mr. Fuchs has surely considered although he failed to mention it, is the fact that anti-particles in the ionospheric layers might have caused the vehicle's heat to become latent, enthalpizing the boundary region and consequently changing the temperature of the boundary. Since, as Mr. Fuchs has pointed out, temperature is a state of energy, this phase change in the directional energy would result in resonance of the vehicle's fugacity with the flow of thermodynamic pulses, invoking Planck's law for the re-radiation of electrons, atoms, or molecules. Such behavior would surely have numerous frightening implications for our space program, such as a stoichiometric warping of the space-time isoclines.

Seriously, we feel that all workers in the aerospace field owe a debt of gratitude to Mr. Fuchs for his humorous interpretations of a science that is too often documented as a series of statistics, and to M/R for continuing to publish his masterpieces. Can we expect a collection of his works to be printed in the near future?

T. E. Bowman
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N. L. Jennings
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Research Laboratories
Martin Company
Denver, Colo.

Playboy Philosophically

To the Editor:

I was interested to see in the current issue of *Playboy* magazine (not far from the gatefold if I recall correctly), an amusing short article on the development of Santa Claus's sleigh "as it might have been reported in Missiles and Rockets."

It was a fairly skilled parody on the engineering-ese and Pentagon-ese with which you, along with everyone else in the field, are involved. That you were singled out for mention should not disturb you—it isn't everyone who can "make" *Playboy*, after all.

Congratulations (or something).

Al Goodman
St. Louis

Although we are, of course, only slightly acquainted with the publication mentioned, we are gratified by Reader Goodman's report. Perhaps we can find a way to reciprocate (?).—Ed.

Perversity of Pagination

To the Editor:

In the Nov. 15 issue of M/R, an article entitled "New Third Stage Considered for Delta" begins, and appears to end, on page 18. The next page, "Technical Countdown," is numbered 21.

On page 28 is the start of a story entitled "AE-B To Probe Higher in Atmosphere." It seems to be concluded on page 32, following an advertisement on page 31.

Query: What happened to pages 19, 20, 29 and 30? Have I missed something due to binding problems?

Frank McConnell
San Francisco

P.S. I have noticed the same thing in previous issues.

And we have attempted to explain on previous occasions. Postal law requires us to allow page numbers for our insert cards (subscription and reader service), which are larger than most. Consequently, we seem to skip several pages in every issue.—Ed.

NASA Special Issue

To the Editor:

Your Fifth Annual NASA Issue, dated Nov. 29, is a fine contribution.

Edward G. Fleming
Chicago

NASA ISSUE

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The Countdown

WASHINGTON

Go-Ahead Seen for Nike-X

Washington insiders still believe a decision will be made to proceed with production of a limited *Nike-X* system, which has the strong and unanimous support of the Joint Chiefs of Staff. But it is expected that the amount requested for the program will be one of the finest-honed figures ever to be found in a Dept. of Defense budget. In other words, just enough to keep the heat off in a decision that will not completely satisfy nor alienate anyone on either side of the anti-ballistic missile controversy.

Will Minuteman III Please Stand Up?

Improvements being developed for Air Force's *Minuteman* ICBM beyond those already incorporated in *Minuteman II* are causing the designation *"Minuteman III"* to be heard more frequently around the Pentagon. These modifications involve virtually every area of the missile and some have been called "remarkable." There still is a sharp difference of opinion within both DOD and Air Force, however, as to whether the improved version should be billed as a distinctly different weapon.

MOL Budget Status Is Uncertain

One factor inhibiting news about the Air Force *Manned Orbiting Laboratory,* aside from security, may be *MOL's* uncertain fiscal status in the upcoming budget. Congressional informants tell COUNTDOWN that some DOD officials are trying hard to tone down the schedule and scope of the project in the face of mounting war costs in Vietnam.

NASA Budget of $5.25 Billion Forecast

NASA's Fiscal '67 budget is expected to be in the neighborhood of $5.25 billion, according to Rep. Joseph E. Karth (D-Minn.) of the House Space Committee. Included in this will be $100-150 million for Project *Voyager,* which is expected to cost $1.5-2 billion over its lifespan.

SA-2 Evasion Working Well But . . .

There is mixed reaction in Washington to Saigon reports that the North Vietnamese have launched more than 150 Soviet-built *SA-2* surface-to-air missiles in bagging only nine U.S. jets. Officials say initial fear of these weapons is gone and evasion techniques have been successfully developed and applied. However, the missiles thus far have been fired singly rather than in salvos, which would be harder to evade. It also is pointed out that a better version of the Soviet weapon, the *SA-3,* has been developed although not yet introduced in Vietnam.

Wendover Gets Nod for Space Landings

A Dept. of Defense committee studying potential recovery sites within the U.S. for polar-orbiting spacecraft favors Wendover Auxiliary AFB in Utah. The report says that 31 sites were studied, with the list then narrowed to Wendover, Edwards AFB in California and Hollman AFB in New Mexico. Edwards apparently lost points because of proximity to a large metropolitan area and Holloman because of nearness to the Mexican border.

INDUSTRY

Boeing Ships Lunar Orbiter

First prototype of the *Lunar Orbiter* was scheduled for shipment Dec. 10 from Boeing's Seattle plant to the Deep Space Tracking Station at Goldstone, Calif. First ground-test spacecraft is due at Cape Kennedy in February and first flight spacecraft March 23. A June flight is anticipated.

Northrop Enters Target Missile Program

A $1.7-million contract held by Northrop's Norair division for Naval Missile Center's *Bomarc* target missile program calls for installation and calibration of equipment in a newly constructed launch complex at Vandenberg AFB, Calif. Operational and maintenance phase of the three-year contract, which includes firing of *Bomarc A* missiles, begins next March. The missiles, modified and redesignated *CQM-10A,* will serve as targets for Navy and Air Force air-to-air and surface-to-air weapons. Naval Missile Center has obtained 125 of the missiles for target use.

Aerojet Completes 260-Inch Loading

Second 260-in. solid motor to be built has been loaded with 1,680,000 lbs. of propellant at Aerojet-General's Dade Division in Florida. Nine days were required to mix and pour the propellant, compared with 11 days for the first 260-in. motor, fired by Aerojet last Feb. 25. Loading was completed Dec. 9. Firing is scheduled for mid-February, with peak thrust of 3.57 million lbs. anticipated.

McDonnell Tests Gemini 8

The *Gemini 8* spacecraft is currently undergoing systems tests at the McDonnell Aircraft plant in St. Louis. Extravehicular simulation is also being run in chamber tests. Spacecraft is due for delivery to Cape Kennedy shortly after Jan. 1.

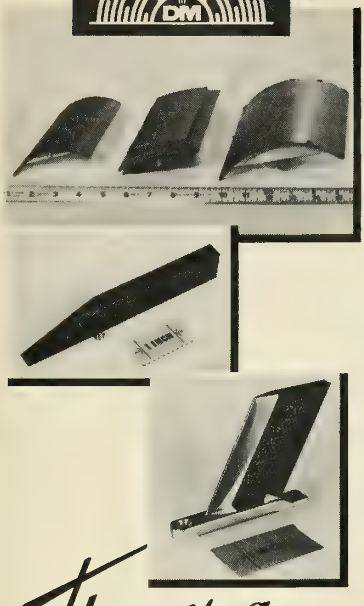
INTERNATIONAL

French Manned Shot Is Forecast

A French newspaper says that nation can produce a large enough rocket to permit orbiting of an astronaut in five or six years. There are no known plans for such a project, however. With last week's successful orbiting of *FR-1,* France now has two satellites launched, with a third scheduled for January.

Germany Joins Drone Project

West Germany will join with Canada and Britain in development of the Canadian-designed *AN/USD-501* airborne surveillance drone system. Germany will pay one-third of the total cost of the program. The missile-shaped wingless drone is being developed by Canadair Ltd., a general Dynamic subsidiary, to provide tactical information in forward battle areas. Eight feet long, it is propelled by a jet engine along a preselected course, parachuting to the ground after return to base.



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The Missile/Space Week

Surveyor Deficiencies Righted

The *Surveyor* program now appears to be on the right track although newly scheduled testing may run costs up an additional $10 to $15 million, Rep. Joseph Karth (D-Minn.) reports.

Karth, chairman of the House Space Committee's space sciences and applications subcommittee and leader of a panel which reviewed the *Surveyor* project earlier this fall, said that deficiencies pointed out in the report (M/R, Nov. 1, p. 16) have largely been corrected.

Returning from visits to Jet Propulsion Laboratory and Hughes Aircraft Co. to review the *Surveyor* project, the third-ranking Democrat on the House committee said that management difficulties and lack of communication between NASA headquarters, JPL and the contractor seem to have been eliminated.

He voiced approval of a testing schedule which now calls for seven thermal/vacuum tests, some for the 66-hour mission duration to be carried out before the launch scheduled for next May. Karth said he was a firm believer in extensive ground testing, and he was now "confident we will have a working spacecraft."

Karth said he felt it was good judgment to reschedule the launch of the *Surveyor* for May in the face of a pad conflict with *Atlas-Centaur* in March. He indicated he had not been at all confident that proper testing could have been accomplished under the original launch date set for December.

Reporting on a visit to Boeing Co. on the *Lunar Orbiter* program, the congressman praised highly the work of Langley Research Center and the contractor. The program is meeting testing schedules and is well within cost, Karth said.

NASA Lists Top Contractors

North American Aviation, Inc., again headed the list of NASA's top 100 contractors with total awards of $1,099,448,000 for Fiscal 1965 (M/R, Nov. 29, p. 43).

According to the space agency's annual procurement report, released last week, the 100 top firms received $4,141,434,000 out of a NASA FY '65 procurement of $5.187 million. Of the top 10 contractors in terms of money received, only one is new to the list. Radio Corp. of America, ranking number 11 in the FY '64 breakdown, placed number 10 for Fiscal '65. Chrysler Corp., number 9 last year, dropped to number 11.

Other firms ranking in the top 10, their FY '65 position and their FY '64 position follow: Boeing Co. (FY '65, 2—FY '64, 4); Grumman Aircraft Engineering Corp. (3-5); Douglas Aircraft Co. (4-3); General Electric Co. (5-7); McDonnell Aircraft Corp. (6-2); IBM Corp. (7-10); Aerojet-General Corp. (8-8); and General Dynamics Corp. (9-6).

M-1 Program Dropped

The space agency has officially cancelled the M-1 engine development program because of lack of any firm application, a move that has been expected for some time.

NASA is allocating $2 million in FY '66 reserve funds to wind up tests on the Aerojet-General Corp. project. The termination will take effect next spring. The 1.5-million-lb.-thrust engine was authorized in 1962 and has cost $127 million to date.

Still uncertain is the fate of the 260-in. solid motor program and the SNAP-8 nuclear powerplant. Both are Aerojet projects.

Shots of the Week

Astronauts Frank Borman and James Lovell were lofted into orbit in their *Gemini 7* spacecraft Dec. 4 aboard a *Titan II* booster. (See story on p. 12.)

- France's *FR-1* satellite was successfully launched Dec. 6 from Vandenberg AFB, Calif. A NASA *Scout* booster placed the 135-lb. payload into a near-polar orbit with an apogee of 480 n. mi., perigee of 462 n. mi., and inclination of 76 degrees. The satellite, built by the French National Center for Space Studies (CNES), is designed to measure electron densities and radio wave propagation. Expected lifetime is three months.

- The Soviet Union's *Luna 8* spacecraft crashed on the Moon Dec. 6 in an apparent attempt to soft-land an instrument package on the lunar surface. The spacecraft was launched Dec. 3. All systems functioned normally, "except the final touchdown," Tass reported. *Luna 8* was the fourth Soviet attempt in seven months to soft-land on the Moon.

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A recent breakthrough in materials for hardened heat shields will help ballistic vehicles penetrate harsh environments — ranging from the shock of radiation to fireball traverse.

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For further information, please write to: Bristol Aerojet Limited, Banwell, Weston-super-Mare, Somerset, England.

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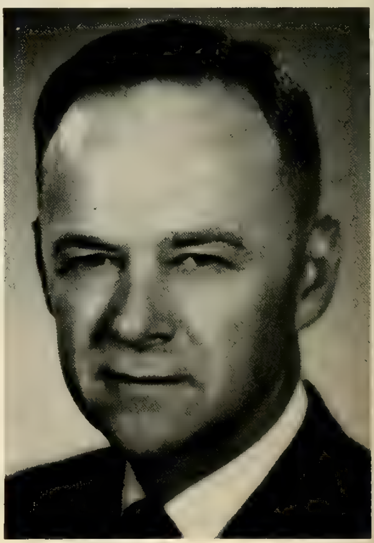
- The Navy fired a *Polaris A-3* missile Dec. 6 from the USS Benjamin Franklin, submerged 30 mi. off the coast of Florida. *Gemini 7* astronauts Frank Borman and James Lovell observed staging of the missile but not nose fairing separation. It was the first submerged *Polaris* launch off Cape Kennedy in more than eight months.
- A French *Centaure* rocket was launched Dec. 7 from Sardinia by the Italian Defense Ministry in collaboration with the European Space Research Organization (ESRO). Purpose of the shot was to gather information on atmospheric particles between 60 and 100 mi. altitude.

Larsen Gets DDR&E Post

Dr. Finn J. Larsen has begun his new duties as Principal Deputy of Defense Research and Engineering.



His appointment to the post was announced Dec. 2 by President Johnson (M/R, Dec. 6, p. 9).

Larsen is a former Assistant Secretary of the Army for R&D and had most recently been a corporate vice president of Honeywell, Inc.

Lockheed on ESRO Team

Lockheed Missiles and Space Co. will serve as technical consultant to a European team chosen to design and build a highly eccentric orbit satellite.

The European Space Research Organization (ESRO) has named Junkers of Munich, Germany, to head the development team. Other members include Messerschmitt A.G., Augsburg, Germany; Etudes

Techniques et Constructions Aerospatiales, Charleroi, Belgium; SNECMA, Paris, France, and British Aircraft Corp., London. Total contract award is approximately $6.5 million.

The satellite will be launched by a *Thor-Delta* from Cape Kennedy during the second half of 1968. Purpose will be investigation of charged particles in space and the effects of magnetic fields on the particles.

Dr. Dryden Interred

Dr. Hugh L. Dryden, deputy director of the National Aeronautics and Space Administration, who died of cancer on Dec. 2, was buried in Baltimore last week in a ceremony in which four astronauts served as pallbearers.

The 67-year-old scientist, whose career began with the birth of aviation and ended with the opening of the Space Age, was the first and only man ever appointed to the NASA deputy post. One of the many tributes to his contributions came from Administrator James E. Webb, who said "he will be sorely missed in NASA, in the nation, and indeed, in many nations." *(See Editorial, page 46.)*

Bothmer on Defense Council

Clyde Bothmer has been named executive secretary of the Defense Industry Advisory Council. He replaces Samuel W. Crosby, who resigned last September.

Bothmer was formerly director of NASA's Office of Industry Affairs in the Pentagon.

Soviet Defense Money Up

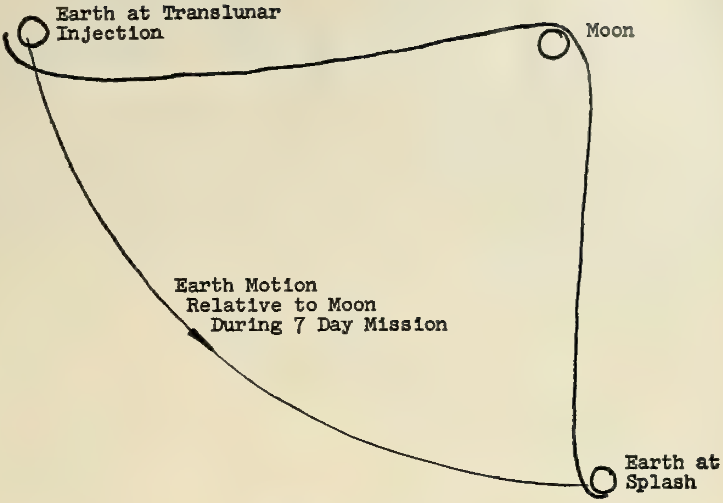
USSR defense spending will increase by 5% in 1966, Finance Minister Vasily Garbuzov has announced.

The $666-million rise in the defense budget was outlined at this month's meeting of the Supreme Soviet, reversing a two-year trend of announcing defense cuts at the annual meeting. The Soviet official indicated that the boost was a result of the war in Vietnam.

Kimball Named to New Post

Dan A. Kimball has been named chairman of the executive committee of Aerojet-General Corp.

Replacing Kimball as Aerojet board chairman is M. G. O'Neil, president of General Tire and Rubber Co., Aerojet's parent firm.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Gemini 8 May Still Go in February

Space agency may substitute passive target for Agena and put program back on schedule—if Gemini 7/6 rendezvous succeeds

NASA IS CONSIDERING a major change in the *Gemini 8* mission, but its approval hinges heavily on a successful rendezvous this week of the *Gemini 7* and *Gemini 6* spacecraft.

An authoritative space-agency official told MISSILES AND ROCKETS that the change under study would permit the two-man spaceflight series to stay on schedule by getting *Gemini 8* off in February.

Reportedly, the change involves replacing the trouble-plagued *Agena* target vehicle on *Gemini 8* with a passive target which would be equipped with a docking collar.

Charles Mathews, director of the *Gemini* program at the Manned Spacecraft Center, said that several proposed target vehicles are under consideration, but that nothing is firm at this point.

Serious consideration of the new mission apparently depends upon two things—a successful rendezvous between *Gemini 7* and *6*, which is now scheduled for no earlier than Dec. 13 or Dec. 14, and NASA's estimate as to when the *Agena* target vehicle will be available.

It is scheduled to undergo wind-tunnel tests at the Arnold Engineering Development Center in February (M/R, Dec. 6, p. 16). While NASA reports officially that the tests—designed to solve the problem which caused the target vehicle to explode on Oct. 25 during an earlier *Gemini 6* launch attempt—will last two to three weeks or longer, it is known that the Air Force developers of the *Agena* wanted the tests to run for four months.

The tests could put the *Gemini 8* launch off until March or April at the earliest. Even further delay is possible.

- **Agena bypassed?**—While NASA's official schedule called for a *Gemini 8* launch in the second quarter of next year, it is known that its unofficial schedule called for it to lift off in February if earlier flights were successful.

Thus, if the substitute target vehicle could be ready in time, *Gemini 8* could still rendezvous and dock with it in February, with the first *Agena* docking mission delayed until *Gemini 9*.

Among the possible docking vehicles are an almost passive target which would have a docking collar and a reaction control system, an inflatable structure, or a vehicle which could be ejected by *Gemini 8* after it is in orbit. Another possibility is a boilerplate *Gemini* spacecraft left over from the unmanned ballistic flights.

While NASA studied the possible new mission, the record-setting *Gemini 7* spacecraft continued its almost-perfect flight and technicians at Cape Kennedy continued last-minute preparation for the launch of *Gemini 6* on either Dec. 12 or Dec. 13.

Late last week, *Gemini 7* had chalked up its fifth day in orbit with all systems working perfectly, and NASA officials saw no reason to believe that its planned 14-day flight would not be completed on Dec. 18.

If successful, the flight will set a new record for manned spaceflight duration. In addition, it has already marked the first time that U.S. astronauts have flown in space with their spacesuits off and the first time that U.S. astronauts have performed an orbit-changing maneuver manually, using the stars for reference.

- **Gemini 6 pushed**—As soon as *Gemini 7* was launched successfully, however, the real drama shifted back to Cape Kennedy. NASA, Air Force and industry engineers rushed to the task of getting *Gemini 6* off the pad in the precedent-shattering time of eight or nine days.

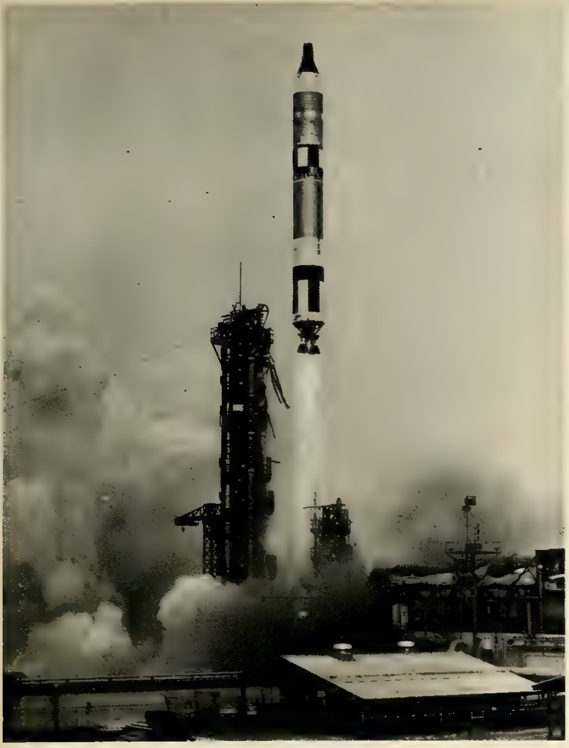
The first stage of the *Gemini 6 Titan II* booster was erected shortly after midnight on Dec. 5 and the second stage was erected at 6:00 a.m., three hours ahead of schedule.

At 12:40 p.m., the spacecraft was erected and mated to the launch vehicle, 3½ hours ahead of schedule. Electrical power was applied to the booster at 1:30 p.m. Preparations were going so well that at one time assembly and checkout of the launch vehicle and spacecraft were running 10 to 20 hours ahead of schedule.

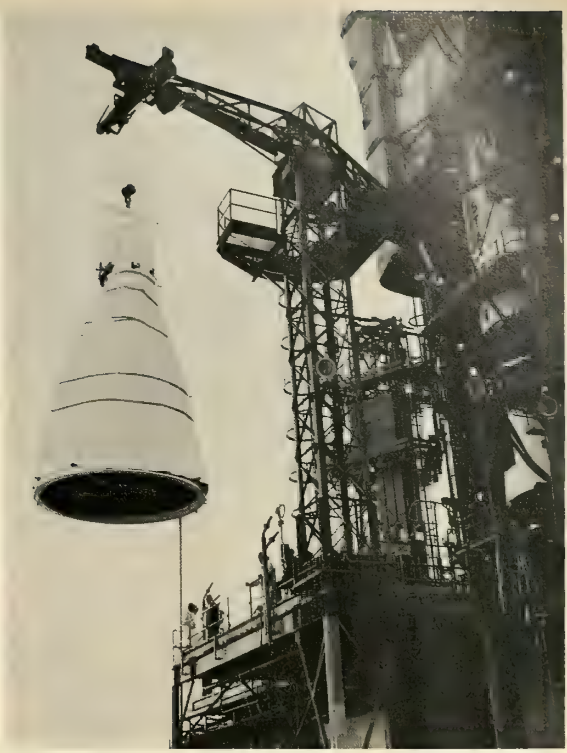
Everything continued to proceed smoothly until navigation and guidance tests were begun on Dec. 7. Then the memory bank for the computer was wiped out. It was replaced by a new computer and early on Dec. 8, NASA announced that it had been checked out and the full flight simulation test would begin shortly after noon on that same day, approximately 12 hours ahead of schedule.

NASA later announced that the full flight simulation test had been com-

ASTRONAUTS Borman and Lovell close pressure suits during practice prior to launch.



GEMINI 7 rises from Kennedy Space Center at 2:30 p.m. plus three seconds, after uninterrupted countdown.



LESS THAN 24 hours after Gemini 7 liftoff, Gemini 6 is hoisted for mating to its Titan II booster (right).

pletely successful and that preparation for *Gemini 6* was then 20 hours ahead of schedule. Officials said they hoped to pick up the other four hours needed to gain a full day in the launch schedule by noon on Dec. 9, when the launch precount was scheduled to start.

Officials also said that at the same time they would decide whether to change the *Gemini 7* orbit in order to optimize for a launch on the eighth or ninth day. If the orbit were optimized for a Dec. 12 launch, two launch windows would open—at 9:49 a.m. and 11:25 a.m., EST, respectively. If the decision were to optimize for a Dec. 13 launch, the two launch windows would open at 9:34 a.m. and 11:09 a.m. EST.

These officials said chances for a Dec. 12 launch appeared to be good, but that this could change if any technical problems developed. Final decision on the launch date was not expected until late last week.

Following the *Gemini 6* launch, the rendezvous with *Gemini 7* is expected to be completed early on the second day.

- **Within three seconds**—The *Gemini 7* spacecraft with pilots Frank Borman and James A. Lovell lifted off Pad 19 at Cape Kennedy only three seconds behind the scheduled 2:30 p.m. EST launch Dec. 4.

The *Titan II* engines were reported to have ignited on time but took three seconds to nudge the Martin-built booster with its heaviest manned payload to date (7,250 lbs.) off the pad. The weight increase was attributable to a two-week supply of consumables and rendezvous equipment consisting of an L-band transponder and two high-intensity acquisition lights.

Mission planners picked the 2:30 p.m. launch time to phase proper lighting conditions into the primary recovery area on the last day of the marathon two-week mission. This added a constraint to the *Gemini 7* launch in that the extreme east Atlantic—in darkness at that time—required near-perfect weather and sea conditions during night recovery operations in the event of an aborted mission after liftoff.

Despite a "hotter" second-stage engine, the booster encountered a 12-fps underspeed condition, inserting the two-man McDonnell spacecraft into an 87.2-177.1 n. mi. orbit instead of the planned 87-183 n. mi. ellipse.

Communications during the boosted phase of flight and early part of the first revolution were "noisier" than usual, but cleared up rapidly afterward. Elliott See, capsule communicator on the Red Team under Flight Director Christopher C. Kraft, commented that the quality of communications during subsequent orbits was actually superior to that of previous missions.

- **Station keeping**—Prior to orbital insertion, Borman applied a 2-fps posigrade burn, using aft-firing thrusters, to separate the spacecraft from the booster. He yawed the spacecraft 180 deg., and, facing the oncoming booster, nulled relative velocity with a 6-fps forward thrust to begin station-keeping maneuvers within 50-60 ft. of the slowly tumbling second stage.

Shortly afterward, the crew noted a drop in pressure in the fuel-cell reactant's oxygen supply and was instructed to cross-feed repressurization from the ECS O_2 bottle—a modification based on *Gemini 5* experience.

The cross-feed valve linking the O_2 supplies allows the repressurization system of one container to repressurize the contents of the other in the event of a heater malfunction.

To hold down losses of hydrogen and oxygen through overboard venting, the crew began controlling the rate of repressurization by manually cycling the heating switches in each container. Kraft

THIS REPORT on the start of Gemini 7/6 mission was prepared by NASA Editor Hal Taylor, at Cape Kennedy, and Contributing Editor Jinx Mercer, at Mission Control Center, Manned Spacecraft Center, in Houston.

indicated that they would attempt to stay about 50 psi above the consumables' two-phase (gas-liquid) state. He referred to this as "riding the dome."

• Radiation check—Following station-keeping exercises, Borman performed a 10-fps downward radial maneuver thrust to hold the spacecraft in an orbit of period equal with that of the booster for an infrared-sensing experiment (D-4/D-7).

A 16-lb. package of instrumentation was rotated out from the adapter section of the spacecraft and, by sighting through the command pilot's window reticle, was pointed at the booster.

Shortly afterward, the Delta P light flashed red on the panel, indicating a pressure differential across the fuel-cell membrane which separates hydrogen from oxygen gas. However, fuel-cell efficiency showed no degradation following periodic purges and ground experts concluded that the light was probably being triggered by an "accumulation" of small tolerances.

Lovell reported actuating the cardiovascular reflex conditioning cuffs around his thighs in the third hour of flight.

The tri-axis, flux-gate magnetometer and the proton-electron spectrometer were turned on shortly thereafter to begin measurements of the radiation environment immediately outside the spacecraft as it passed through the South Atlantic geomagnetic anomaly.

Both Borman and Lovell began making self-checks of their vision early in the mission, using the onboard S8-D13 vision tester, and after several "training" passes over the ground targets at Laredo, Tex., began acquiring the targets in sufficient time to read the orientation of the markings.

• Intruder—A perigee-adjust maneuver at 3 hrs. 47 minutes in the flight lifted the low point of the orbit to 119.9 n. mi. The 59-fps "burn" without platform was interrupted, the crew reported, when "a tape, a piece of paper, or a strap" appeared in Lovell's window at the right side.

The object at first was thought to be a strip of magnesium alloy, one-inch wide, which is severed from the aft rim of the spacecraft adapter during booster separation just prior to orbital insertion. Later, however, the crew described the object as appearing to be white, rubbery and jagged, and resembling calking material. Kraft commented that they would send *Gemini 6* up in a few days to make a closer inspection of the mysterious object. In the meantime, McDonnell engineers were making a thorough inspection of their spacecraft in St. Louis to gain insight as to the possible location of such material.

Lovell removed his suit during the second day of flight and reported that he was feeling quite comfortable.

• Disappointments—A photometer used to measure the radiant intensity of known stars before and after they become occulted by the atmosphere—a Dept. of Defense experiment to evaluate an autonomous navigation technique—ran into trouble early in the mission, when the light from the faulty Delta P indicator apparently "saturated" the sensitive equipment.

The MSC-4 optical communications experiment, an attempt to communicate from the spacecraft to the ground on a laser beam, was postponed to the third or fourth day in the mission due to ground equipment problems at the Ascension and Hawaiian Island sites. Later, a fire was reported to have damaged power-generating equipment at the Ascension Island site.

Star-to-horizon measurements using a modified hand-held sextant were begun in the second day of the mission. The sextant is an improvement over the one used during the *Gemini 4* mission last June 3-7.

• Polaris tracked—At 47 hours 55 minutes and 37 seconds into the flight, Borman successfully acquired the *Polaris A-3* missile launched from the submarine Benjamin Franklin, submerged approximately 30 miles east of Cape Kennedy, and tracked it for about three minutes—almost from the time it broke through the water surface.

While Borman tracked the object through the reticle, Lovell took pictures.

The pilots sighted the missile as they crossed the Cape Kennedy longitude. It was believed to be 125-130 n. mi. in slant-range distance at the closest approach.

• Photometer studied—The star occultation photometric equipment for the D-5 experiment which began malfunctioning early in the flight was undergoing extensive checkout with similar equipment on the ground.

Charles Bassett, capsule communicator on the Blue Team, reported that a space checkout of the photometer—a calibration on the planet Venus—might be attempted in the 62nd revolution.

The photometer also supports another experiment called "landmark contrast" measurements, which are intended to verify some of the design data used for the *Apollo* guidance and navigation system.

The extent of contrast in specific landmarks such as islands, peninsulas, delta regions and land-water boundaries will be viewed from outside the Earth's atmosphere and measured for contrast value with and without special filters provided by M.I.T., initiator of the experiment. Experimenters wish to determine whether the contrast of a given landmark is sufficient or whether its contrast number can be improved through filters changing its spectral response.

• Plans modified—Ascension and Hawaiian Island ground-receiver sites for the laser optical communications experiments were added to the *Gemini 7/6* plans when the space agency had to shift the orbital inclination of *Gemini 7* to provide more favorable launch windows for *Gemini 6*. This "pulled" the original site at White Sands Missile Range, N.M., slightly too far north of the *Gemini 7* passes, which consequently became infrequent and very low on the horizon. Experimenters felt that they risked atmospheric scattering and laser beam attenuation at these low penetration angles.

Setting-up and equipment problems developed at these two remote sites early in the mission. During a first attempt to use the Ascension site, the experiment was cancelled when clouds moved in over the area.

The brain-wave measurements to calibrate depth of sleep through electrical encephalograph contacts on Borman's scalp terminated abruptly when the electrodes were accidentally torn loose. Earlier, the contacts on the other side of his head loosened and an attempt was made to replace them with a special kit astronauts carried on the spacecraft. Approximately two days of data was collected and recorded on the biomedical tape recorder.

• Scorecard—Three days into the mission, the experiments completion schedule looked like this:

—D-4/D7 radiometric measurements—53%. Out of a possible 38 measurements during *Gemini 7* to obtain basic data across a broad band of the electromagnetic spectrum, 16 had been already completed. One detector in a cryogenic "bath" (liquid neon —397°F) was designed to make long-IR wavelength readings of space cold objects. A second spectrometer read in the warmer IR ranges, and ultraviolet detector added to the radiometer would be used to obtain noise-free, high-strength UV reflectance measurements of the Moon. The equipment, which has a 2-deg. field of view, is aligned along the longitudinal axis of the spacecraft and measurements are made by sighting through the command pilot's window reticle.

On schedule for D4/D7 are measurements of ion sheaths made by vehicles re-entering the Earth's atmosphere.

—D-5 star occultation measurements—20%.

—D-9 simple navigation (sextant)—60%.

—S-8/D-13 visual acuity—36%.

—MSC 2-3 radiation experiment—43%.

—S-5 terrain photos—22%.

—S-6 weather photos—57%. ■

More Responsive GAO Attitude Seen

But industry observers want disclosure of House subcommittee report on DOD contractor grievances from summer hearings

AIRING OF GRIEVANCES of the Defense Department and its contractors against the General Accounting Office by the House military operations subcommittee appears to have resulted in a better working atmosphere since that time. Especially apparent is a less accusatory tone in the language of GAO "blue book" reports to Congress.

The subcommittee, headed by Rep. Chet Holifield (D-Calif.), has not yet issued a formal report nor its recommendations concerning the disputed areas, but some subtle changes are evident in GAO contractor audit dealings since the hearings closed last July.

While the actions cannot be expected to be considered definite future policy because of the impending appointment of a new Comptroller General, observers have noticed "a measure of responsiveness by GAO to the issues generally concerned about."

Most contractors and the Aerospace Industries Assn., which took an active part in the hearings, are adopting a wait-and-see attitude. Some fear that unless the subcommittee's report, which is tied up in the full House Government Operations Committee, is not issued publicly, the investigation may not be as effective as it could be.

- **A change in position**—One of the most significant points at issue last year was the fact that the GAO for the first time had attempted to exercise authority to disallow government payment to a contractor when GAO disagreed with actions by a contracting officer in allowing costs.

One such case was widely discussed during the hearings. In this, production of a certain engine was to be transferred from one company to another. The Navy then asked the original company to draw up a technical data package to facilitate the transfer, for which it paid roughly $1 million.

The GAO, however, disagreed that the Navy should pay for this material on the basis that it should be furnished under the original contract, in spite of the Navy's insistence that it was work beyond the original contract. The GAO then took steps to recover the part of the payment already given by the Navy to the contractor, and instructed the Navy to stop payment on the remainder.

Regardless of the basis of the disagreement, the question was whether the GAO could disallow payment a contracting officer had approved, thereby creating two positions for the government.

Some four or five similar situations had arisen during the last year or so. However, the GAO reportedly has retreated recently from its position on all of these.

- **Management function**—In general terms, there appears to be no change in the basic philosophy of the function of the GAO, although some testimony had asked less GAO involvement in management-type judgments.

The legislative act and accretion of subsequent statutes that have provided a framework for GAO's powers are broad. Since a number of committees ask GAO to do a number of special functions over a wide area, Congressional observers point out that it is unlikely that the GAO's role could be recompressed into the initial audit function.

However, Congress itself has overruled the GAO in some instances, including the controversial question of automatic data-processing equipment. GAO has campaigned for some time for government-wide ownership and pool use of ADP equipment, using defense contractors as examples of "waste" through use of leased rather than government-owned equipment.

While a bill was passed last session setting up a government pool for ADP, it provides for the exclusion of certain DOD and NASA research and development work.

Recent reports to the Congress also reflect a more tentative attitude on GAO's part in which it appears to concede that judgments in some areas may differ. Such phrases as "In our opinion . . . on the basis of our findings . . . we are recommending that they reconsider . . ." appeared in a report dated October, 1965. This contrasts sharply with previous reports with flat statements asserting "our review disclosed" "mismanagement," "waste" and the like.

- **Blue books**—Perhaps the most obvious change is in the language of the blue reports to the Congress that were issued in September and October.

Excerpts from recent titles read "Potential Savings by Direct rather than Indirect Purchase of Selected Major Subsystems . . . ," "Review of Procurement for . . . ," "Costs Incurred in Procuring . . . ".

These represent a real departure from "Higher Costs Resulting from Failure to Procure Directly from Manufacturer . . . " "Overpricing of Target Cost . . . ," "Excessive Prices Negotiated . . . ," and "Erroneous Purchase . . ." These titles, characteristic of those that appeared in 1963 and 1964, usually included the company's name, representing an indictment by title alone.

Language within the books issued since the subcommittee's hearings tends away from the bold assertions which in effect invested government contractors and often the government with bad faith.

While earlier reports flatly stated that the contractor or the government agency had not done such and such, an October, 1965, report contains this language: "Our review *indicated* that (the agency) had not established adequate procedures for obtaining confirmatory . . ."

Reports issued during the last few months also have not carried the statement that the case was being referred to the Justice Department, which appeared frequently in previous actions. Contractors pointed out that such statements were often misunderstood and tended to indicate fraud.

GAO said during the last hearings that in the future any case it was referring to the Justice Department would be noted in the letter of transmittal to the Congress. However, the number of such referrals is reported to have dropped considerably in the last few months.

It also is reported that the Justice Department has responded to criticisms of the delay in clearing some of these cases, and has reduced its backlog considerably.

One or two of the reports from the last month or so have listed those things the GAO did not take into consideration in arriving at its viewpoint, another omission deplored by contractors previously.

Some observers also have noted a cooperative attitude by the GAO in guaranteeing that contractor proprietary information does not appear in its public reports.

Blue books in recent months also have been mailed to the contractors and government agencies involved in order that they receive them at the same time rather than after they appear in news media. This was another sensitive point raised in the hearings. ■

REFURBISHMENT of Redstone missiles proceeds at the Michigan missile plant of Chrysler Corp. near Detroit. The Redstones are being reworked for use in a Navy/ARPA portion of ARPA's Project Defender. Chrysler was prime Redstone contractor.

Navy Firing at Redstone Targets

Use of refurbished missile as target may aid in studies of fleet ABM potential; SPARTA launchings to begin next summer

by Michael Getler

U.S. ARMY *Redstone* missiles, formerly on station with the Seventh Army in Europe, are now being launched as target missiles from the Pacific Missile Range (PMR).

The launchings are part of a joint Navy/Advanced Research Projects Agency (ARPA) missile defense research effort (M/R, Aug. 9, p. 15) being carried on as part of ARPA's Project Defender.

First firing of a *Redstone* in its new role took place Nov. 30. Sources close to the project say this first flight also involved a successful intercept of the *Redstone* by a Navy *Terrier* ship-to-air missile.

Although objectives of the Navy/ARPA effort are classified, the involvement of the Navy and its ship-to-air missiles has given rise to unofficial speculation that the experiments may be aimed at evaluating the potential of an anti-ballistic missile system for protection of the fleet; or for use of missile-equipped ships as a supplement to a larger, terminal-phase ICBM intercept system near coastal targets; or as a defense against submarine-launched missiles.

There have been additional *Redstone* launchings earlier this month, but project sources say only that measurements taken have been "interesting." Informed sources say these early firings are part of an initial phase in the program, which is due to end shortly, and that there is as yet no decision regarding the next phase.

It is believed that of about 23 *Redstones* returned to the U.S. that were suitable for reconditioning, at least five have been earmarked for the Navy/ARPA effort.

- **SPARTA detailed**—Eleven of the *Redstones* are slated for another part of the Defender program, known as SPARTA (Special Anti-missile Research Tests-Australia). These flights, which will not involve target intercept, will be made at the Woomera, Australia, missile test range beginning next summer and continuing for about one year.

The project is a joint U.S.-U.K.-Australian ICBM defense research effort that represents a follow-on to the earlier projects Gaslight and Dazzle (M/R, May 11, 1964, p. 33). Both of these earlier programs used the British *Black Knight* research booster to carry re-entry vehicles to altitude and then propel them back into the atmosphere for re-entry signature studies. Use of the *Redstone* in this role is expected to give researchers a considerable gain in re-entry vehicle weight and velocity combinations.

For this effort, the *Redstone* will be modified with a high-energy upper stage to propel the re-entry vehicles back into the atmosphere. Contractors for the stage, which will probably be a modified version of an off-the-shelf unit, and for the re-entry vehicles, have reportedly been selected, but formal announcement is not expected from the Army's Missile Command until early next year.

Prime contractor for hardware development on SPARTA is TRW, Inc.

The major subcontractor is Chrysler Corp.'s Missile Div., which is doing the refurbishing job on the *Redstones*. The division was *Redstone* prime contractor in the mid-1950's.

● **Funding breakdown**—The total equipment costs of the program in the U.S., including the *Redstones*, the upper stage, and the re-entry vehicles, is said to be about $10 million.

The U.K. and Australian contributions, which are also still in the negotiating phases, are centered primarily around the manning of the Woomera test range and the reduction of test data.

Project sources say Woomera has certain advantages for the Defender flights. The radar, for example, which ARPA built for Project Dazzle, is said to have been an exceptional one that has "unique characteristics," about which its designers will say nothing. The cost sharing inherent in the tripartite arrangement is also attractive in comparison to solo U.S. efforts, say project sources.

The Woomera range is also more available for use than are many U.S. ranges with much more cramped schedules. Vehicle recovery can be achieved at the Woomera overland range, and ground coordinates pertinent to all phases of the flight and measurement are said to be very well defined.

The re-entry vehicles to be used are for U.S. weapons, but the program also has obvious value to the U.K. *Polaris* project, and the missile defense concern of both Commonwealth countries.

● **Reliable bird**—As a weapons system and space booster, the Chrysler-built *Redstone* has achieved an enviable record of 95% successful flights in more than 80 launchings. In its final six years of service, the missile scored 25 consecutive successful flights. The final six were made at White Sands in 1963. The last missile was produced in December, 1959.

Despite its record and the current interest in its use as a test and target vehicle, both Army Missile Command and ARPA sources say there are no current plans to re-open the production line.

The *Redstone* phase-out from Europe was completed last summer, with the missile replaced by mobile *Pershing* missiles.

Chrysler's role in refurbishing the missiles, which was announced in June, involves the entire vehicle. It includes checkout of guidance platforms, in addition to the ground support equipment and erectors. The boosters will be transported to the West Coast test range using the well-known "Pregnant Guppy" aircraft operated by Aerospace Airlines. Chrysler will also static-test the missiles at its Michigan Army Missile Plant and provide launch crews for the missile ranges. ■

TECHNICIAN checks one of two compressed air bottles used to change Redstone altitude.

Rocket Sled To Test Nuclear Effects

THE AIR FORCE will begin tests at Holloman AFB, N.M., next month using a new supersonic rocket-propelled sled to study simulated nuclear blast effects on missile nose cones.

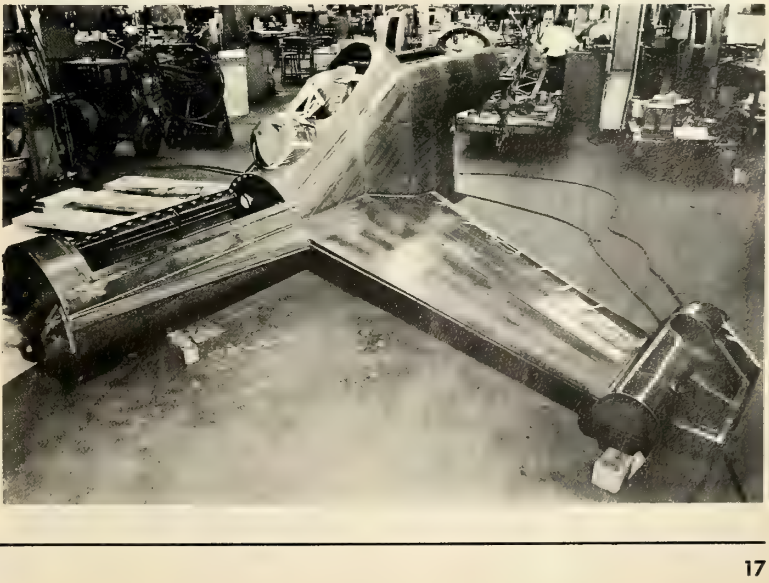
The sled, developed by Goodyear Aerospace Corp., weighs 4,500 lbs. and will travel down the seven-mile-long track at Holloman reaching speeds of 2,300 mph.

It is the heaviest and fastest sled of its kind and is powered by three solid-propellant stages. The first two are clusters of four Navy *Terrier* motors, and the last is a Goodyear-developed solid motor.

Simulation of the blast effects from a nuclear-armed anti-missile missile will be achieved by detonating a high-energy TNT blast when the sled has traveled roughly 13,000 ft. down the track.

The test program is slated to continue for six months, at which time the vehicle's use in other programs is expected. The sled is made from a new ultra-high-strength steel, HP 9-4-25, developed by Republic Steel Corp.

The nose cone will be mounted on the forward end of the sled, with recording equipment housed in both forward and rear centerbody compartments and on an outrigger that will also stow a high-speed movie camera. A ballute device, used for deceleration, can be seen in the photo below partially stowed in the upper center section, behind the nose cone mount.



B-52 Cutback Won't Affect SRAM

Air Force apprised of reductions early in development; missile's use on bomber version of F-111 also likely

DEFENSE DEPT. intention to make large reductions in the numbers of operational strategic bombers over the next few years has not altered plans for development of the Air Force's *Short Range Attack Missile* (SRAM).

Air Force planners were made aware of the intended B-52 and B-58 bomber cuts during the very early stages of *SRAM* development, and planning has been proceeding based upon the missile's use with the residual force of B-52's, estimated at about 250 of the later G and H models, and a strong likelihood for its use aboard a bomber version of the F-111.

Although no decision has yet been made regarding whether or not *SRAM* will get a production go-ahead, Air Force planners say they are optimistic about the missile's future. Both the Martin Co. and Boeing Co. are now engaged in Phase IB project-definition contracts on *SRAM*. This phase is expected to be completed by March 15. An Air Force evaluation will follow, with a single contractor expected to be picked for the full-scale development effort in mid-summer, pending DOD approval.

- **B-111 procurement**—It has been estimated that DOD will request a force of about 200 B-111's, each able to carry possibly six *SRAMs* or a mixed load of other more conventional weapons, as a supplement to the B-52 bomber force remaining in the 1970's.

Secretary of Defense Robert McNamara, who first generated indications that a bomber version of the F-111 would be developed in his statement to Congress in February, cited the fact that since the F-111 was nearing production at that time and *SRAM* had been initiated in the FY '66 budget, the B-111 could be made available faster and for far less cost than the new Advanced Manned Strategic Aircraft (AMSA), which the Air Force is seeking.

SRAM would also be used on AMSA, but that craft would also require considerable new expenditure for development of new engines and avionics. Although AMSA would have definite range and payload advantages over a B-111 (which would have an estimated unrefueled range of about 4,000 miles and be largely dependent upon aerial refueling for missions now assigned to B-52's without refueling), the Secretary indicated that the capabilities of such a craft would be sufficient to bring under attack a very large percentage of an aggressor's urban and industrial complex.

If the February defense posture statement turns out to be a harbinger of the B-111 program, it proved to be less accurate on its estimates of the U.S. manned strategic bomber forces in 1970. In February, the secretary, noting the savings associated with retirement of B-52 "B" versions, indicated a force of about 670 manned bombers in 1970.

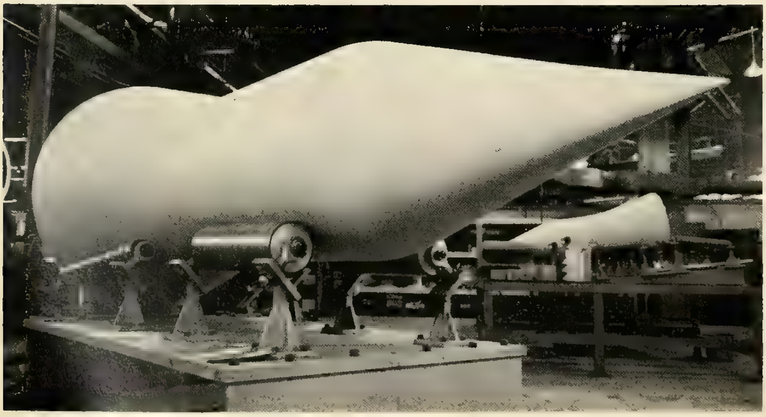
Based upon the newly announced cutbacks, it is now estimated that the Air Force will deactivate about 350 B-52's and all 80 of its supersonic B-58's, leaving roughly 250 B-52's and an increment of B-111's, if they are produced, by 1971.

Current U.S. strategic missile force includes 800 operational *Minuteman I*, 54 operational *Titan II* and about 384 *Polaris* missiles aboard 24 operational submarines. In the period through 1970 an additional 200 *Minuteman II* missiles and 272 more *Polaris A-3* and *Poseidon* missiles should be entering service.

- **Critics irked**—The announced B-52 reductions have already drawn strong fire from several members of Congress, some of which may be countered by an expected announcement of the B-111 development. However, the manner in which the cuts were announced has also irked Pentagon observers.

Early last week McNamara announced that some 149 military activities would be closed, consolidated, or reduced. These bases are located in 39 states, the District of Columbia, and 10 foreign countries. The action, according to DOD, would eliminate more than 53,000 military and civilian jobs, save $410 million per year, and release more than 93,000 acres of land for nondefense use.

It was not until two days later, however, when the list of affected facilities was released, that it became generally known that the base closing indeed involved shutdown of Strategic Air Command bases, and that the seemingly innocuous shaping up of the defense facility establishment was actually a major change in the U.S. strategic posture. ■



Mark 11A Minuteman Re-entry Vehicle Shown

MINUTEMAN II'S Mark 11A re-entry vehicle is displayed before shipment from Avco Corp.'s Lycoming Div., Stratford, Conn., to Air Force. The vehicle is designed, along with its ablative covering, to withstand speeds up to 15,000 mph and re-entry temperatures of 12,000°F. See related item on first flight on page 23.

FIRST MINUTEMAN II firing from an underground silo at Vandenberg AFB was a complete success. Minuteman II's nose cone splashed on target, some 5,000 miles down the Western Test Range. U.S. Air Force's most advanced ICBM, Minuteman II has increased range, improved guidance, more flexible targeting and larger payload. Minuteman missiles can remain on alert in underground silos for long periods with minimum maintenance. As Minuteman weapon system integrator, Boeing continues its responsibilities for assembly, installation, test, launch control and ground support equipment for new Minuteman II.

Capability has many faces at Boeing

LUNAR HOT SPOTS. Boeing scientists, using data they gathered during moon scans, are developing thermal map showing temperature peaks and plateaus of moon surface, as one of many aids in selecting best moon landing spot.

SST. Model of Boeing supersonic jet, which could cross the U.S. coast to coast in two hours. Boeing's variable-sweep wing design provides ideal shape for fast cruise and slow landings.

SIMULATOR in new Boeing Space Center uses earth and moon globes with TV and computer systems to simulate space flight. Pilots "fly" space missions, orbital re-entry and controlled landings on earth and moon. The Space Center is most advanced in private industry.

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The sun's planets have been referred to frequently as outer space. Underway today at Reaction Motors Division of Thiokol are diverse programs directed toward perfecting new and revolutionary propulsion control systems for this environment. For example, intensive research and development activities on newly awarded C-1 (Common Engine), designed for manned use in spacecraft control systems and launch vehicles.

Propulsion control systems are but one example of the broad ranging activities that are attracting talented engineers and scientists to RMD. Others include: Packaged-liquid hypergolic engines, hybrid and reverse hybrid engines, Hi energy systems based on fluorinated oxidizers, advanced systems utilizing thixotropic propellants, space storable propellants.

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Technical Countdown

MATERIALS

Avco Touts New Superconductor

Predictable coil performance with high reliability can now be assured, according to Avco Corp's Everett Research Laboratory, in the use of its newly developed "Supergenic Strip" SG700 superconductor. Designed for use in large, high-magnetic-field superconducting coils, the material is fabricated from nine heat-treated niobium-zirconium wires imbedded in a copper substrate. The product, says Avco, is flexible, rugged and provides properties similar to those of ordinary annealed copper strips. Its current-carrying capacity is four times that of the same material when not heat-treated, the firm claims.

Dark, IR-Reflectant Paint Developed

A combination camouflage and solar-heat-reflecting paint for use on tactical missiles has been developed by the U.S. Army Material Command at Aberdeen Proving Ground in Maryland. The basic problem, scientists there pointed out, was to produce a coating with normally conflicting characteristics—dark, but heat-resistant. First use of the infrared-reflectant paint will be on *Hawk* missiles. Ultimately, instrumentation trailers and vans will be protected. Commercial and industrial applications have been forecast by Army developers.

Mark 11A Survives Re-entry and Impact

Minuteman II's ablative-coated re-entry vehicle successfully withstood 12,000°F-plus temperatures during the first flight test of the new ICBM Aug. 28. First details of the firing, released last week by the Air Force, indicated apogee of the ballistic trajectory was above 400,000 ft.; maximum velocity was 15,000 mph. Impact occurred off Eniwetok in the Pacific. The Avco-developed Mark 11A warhead was recovered intact.

Meteorite Elements Possibly Non-Earth

Examination of the organized elements of the Orgueil Meteorite by quantitative fluorescence microscopy has shown that the fluorescence level of those in the meteorite were about an order of magnitude lower than that of present-day organisms used for comparison. According to Dr. Edward A. Botan of Avco Corp., this indicates a low level of tyrosine in the specimens. This has resulted in postulation that the elements are not Earth-source but inherent components of the meteorite. It also is postulated that the discovery is "a significant bit of evidence in the favor of the 'organized elements' being biological structures."

SPACE MEDICINE

Soviets Document Spaceflight Visual Changes

Soviet *Voskhod II* pilot P. Belyayev, in a paper just translated, says that operational visual effectiveness deteriorated approximately 20 to 30% during the flight, confirming data obtained on *Voskod I.* Visual perception of the brightness of colored objects also was slightly dulled, he said. For certain colors, green and purple, this decrease was as great as 50%.

Accelerations Further Defined

In acceleration studies at the Air Force Aerospace Medical Research Laboratories at Wright-Patterson AFB, it was found that in accelerations having the same root mean square but different peaks, those with the higher peaks were more disagreeable. However, restraint tightness is a critical point in subjective severity rating. In hand-motion observations, used as a measure of the vibration, it was found that non-pilot volunteers could subjectively detect differences in hand-motion error of as little as 10%.

Russians Report on Spacecraft Noise

Recent Soviet reports on the effects of simulated spacecraft noise indicate that continuous noise for 72 hours raised the subject's auditory threshold by 15-20 db. After 10 days, the increase was 20 to 25 db, with function disorders of the "auditory analysor." When the noise was intermittent, up to seven hours a day, the effect was cumulative only after months or even years. High frequency noise, up to 3,000 cps, was studied at a total level of 60-76 decibels.

ELECTRONICS

Altimeter Suggested for Position Fixes

Satellite position could be determined quite accurately with the aid of a radar altimeter, according to Jacques S. Gansler of General Precision, Inc's., Aerospace Systems Div. In proposing such a technique before the recent Space Technology and Science Symposium in Tokyo, he claimed improvement in both speed and accuracy over conventional means. Ground-based trucking support also would be unnecessary, he said.

Bermuda Gets First Apollo TM

First *Apollo* VHF telemetry system, delivered to the Bermuda Station in mid-November, has been successfully tested and has provided a 100% improvement in received data quality, according to NASA's Goddard Space Flight Center. Developed by Vitro Electronics, the system employs three predetection diversity combiners and three dual-channel receivers. A 1,000:1 increase in error improvement over existing *Gemini* ground receiving systems already has been shown in the preliminary tests.

Astronomy

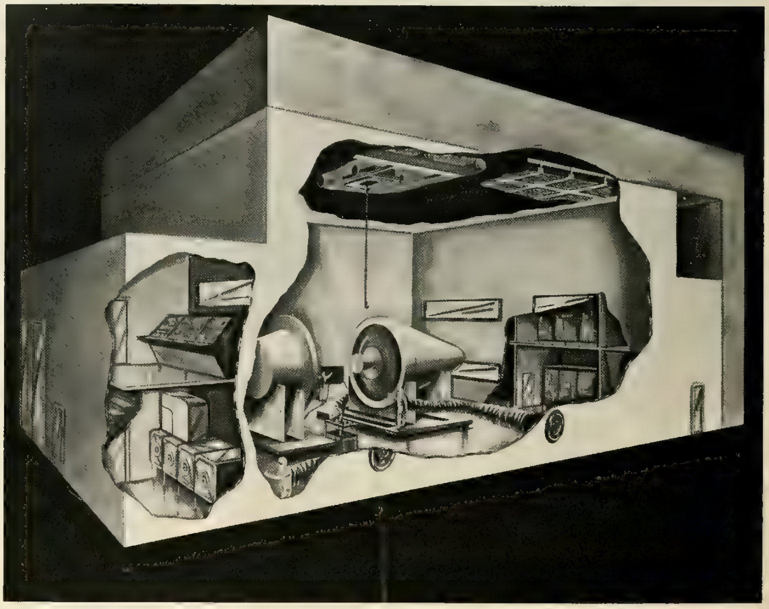
Moon-Blink Team Successful

"Color glows," infrequently observed on the lunar surface, have been successfully photographed by a group of amateur astronomers using a 16-in. telescope. Working on a small research project for NASA from a site at Port Tobacco, Md., the group captured a record of the phenomenon emanating from the crater Aristarchus. During their 16-month effort, two previous moon-blink sightings have been confirmed but because of the short duration of each occurrence, no photographs were obtained, the group said. Thirty-six photos were made—12 each through red and blue filters and 12 without filtering.

GE Proposes Sterilization Facility

Installation, planned for Cape Kennedy, would allow repairs without compromising spacecraft integrity; demonstration soon

by Heather M. David



CUTAWAY drawing of General Electric's proposed assembly sterilizer.

KING OF PRUSSIA, PA.—A new concept in sterilization procedures that would allow last-minute fixes on planetary-bound spacecraft without disturbing their sterile condition will be demonstrated soon by General Electric's Missiles and Space Div.

Instrumental in the concept is a GE facility called an assembly sterilizer, which would be operated at the launch complex at Cape Kennedy. The sterilization facility would not only be the site of terminal sterilization, but would allow repairs or fixes to be made after terminal sterilization without violating the spacecraft's integrity.

The space agency's present plans call for substitution of a backup, sterile spacecraft should something untoward occur in planetary spacecraft after sterilization. Thus, even minor malfunctions that normally could be corrected easily would require substituting a new spacecraft. (M/R, Aug. 9, p. 32).

The ability to enter the spacecraft after it is sterile, GE engineers point out, would eliminate the necessity of many costly backup spacecraft and greatly enhance project reliability.

An analog of a full-scale facility is being built in-house to demonstrate the concept. However, GE is under a Langley Research Center contract to study methods of sterile assembly. The company's decision to build the analog, originally conceived as a desk model but now measuring 10 ft. sq. by 20 ft. high, is part of an overall GE attack on various aspects of the sterilization problem being carried on in a number of its departments.

The sterilization question is receiving strong emphasis in a number of companies, for, as one company executive pointed out, it is one of the largest factors that could contribute toward winning the *Voyager* contract.

Under the concept, the full disassembled spacecraft would be transported into the assembly sterilizer on dollies. This would, Stan Zwerling points out, allow the heat to get to the innermost parts faster than in an assembled condition in a container. Zwerling heads GE's group working on the sterilization facility.

- **Entry**—Collapsible tunnels, through which men would enter from the exterior to completely leakproof suits connected to the ends of the tunnels (see illustration) and then be able to move about to work on the spacecraft and carry out testing functions, would be incorporated into the wall of the room. The tunnel-suit combination, referred to as a bio-isolator suit system (BISS), would keep the men topologically isolated from the room itself. Each BISS would have complete life-support functions in itself, with the tunnel acting as an umbilical to the outside.

The room would have observation windows to ensure the safety of the men and to aid in carrying out testing of the spacecraft. Testing equipment would be provided, with consoles in an exterior chamber.

Another chamber in the facility would be equipped with heat chambers and autoclaves to handle small pieces or components that might be needed to repair or complete the assembly.

As visualized by the company, the full-scale facility would measure 60 ft. wide, 80 ft. long and 45 ft. high, although its dimensions would be affected by the kind of hardware it would be required to handle.

It could be equipped with a crane for vertical assembly and other moving devices. A continual bioassay would be made. Makeup gas would be sterilized by an 850°F incinerator outside the chamber. Flow of gas would be downward, through the floor, across the back of the facility and to the top in an essentially closed loop.

- **Analog**—The analog facility will be a glove-box operation in which some 50 samples will be processed to demonstrate the concept. Test samples will include such things as a piece of the heat shield, structural members, electronic components and circuit boards. These representative pieces will be used to simulate taking the disassembled spacecraft into the assembly sterilizer, sterilizing it, conducting tests with the bioassay and other operating procedures. The electronic pieces will be working units for reliability demonstration.

The main chamber of the box, like the proposed facility, can be heated to 300°F, flooded with ethylene oxide, and has a laminar flow of 90 fpm with dry nitrogen. It also can be taken to 50-60% relative humidity to simulate the conditions that would be created to eliminate static during assembly.

● **Suit and tunnel**—One of the next phases GE engineers under Zwerling will concentrate on is the development of the suit and tunnel. Some of the main problem areas will be in ensuring its biointegrity and human factors, resolution of the life-support and safety problems, and personal hygiene.

The suit, which GE is considering letting for subcontract, would differ from spacesuits in the use of the connecting tunnel, in the necessity for higher environmental tolerances and the ability to be used in the ethylene oxide atmosphere.

The General Electric group hopes eventually to construct a small demonstration unit with at least two suit tunnels, probably at its Philadelphia Chestnut Street plant.

● **Design and manufacture**—In yet another GE department, engineers under H. G. Lorsch have been working on handbooks for spacecraft design and manufacture under NASA contract.

Lorsch told MISSILES AND ROCKETS that although there are problems in design presented by the sterilization requirement, they can be reduced by judicious attention. The major remaining questions would appear to be in the experiments themselves.

One experiment problem under consideration is what nutrients might be used, since some will not support life if they are sterile. However, Lorsch said he felt that by the time a planetary lander is scheduled, these problems will be solved.

Particular areas of design that will need attention are connections, brackets and the like. The design handbook will provide engineers with a rating system to choose various design methods, and will point out trouble spots.

Manufacturing methods are now being studied in terms of what things can be done to facilitate the sterilization process. The goal is to make the components of the spacecraft as clean as possible before the final sterilization.

● **Preventive techniques**—Some fairly simple procedures, GE engineers said, have been found that decrease the number of microbes by orders of magnitude. It was discovered, for instance, that by using a germicidal solvent before welding, the microbial population was cut by 90%.

The use of finger cups, sterile parts and tools and work on a laminar-flow clean bench were found to be very effective. Electronic modules were manufactured using these steps, and it was found that they exceeded "clean" specifications. The same process is being applied to manufacture of a pneumatic component.

GE engineers will manufacture a black box, pneumatic system, and move to the assembly of a mock spacecraft to see what the contamination level is with various methods of assembly.

A comparison will then be made of what costs are incurred in using these techniques or in manufacture in the normal way and trying to render it near-sterile at one shot.

Some areas seen needing attention are in recording equipment, especially tapes, certain semiconductors and transistors, and some soldered connections.

Another area of interest at GE is in the probabilities of post-launch contamination such as by micrometeoroid impact, retro-fire and cold-gas attitude-control jets.

A 300-sq.-ft. laminar-flow clean room is being installed at GE and is expected to be ready by the end of the year. This will be compared with conventional clean rooms and clean benches to determine whether the laminar-flow room can clean dirty parts. This might provide a storage method, if effective enough.

Two sterilizer units also will be installed in the clean room wall for evaluation of their use in a simulated production cycle. These—one an autoclave and one a chamber for ethylene oxide—will be evaluated against one another in terms of operating difficulties.

● **Personnel**—In the final analysis, it may be up to the contractor for a particular spacecraft to prove that it is sterile. With the kinds of minute numbers involved, it may be impossible to test to discover whether or not the equipment is indeed sterile.

Yet another group in GE is concerned with the development of an entire discipline of sterility control that would be applied to a company or even its subcontractors in somewhat the same manner as quality control is now used.

As now planned, the sterility control office would report directly to program management.

Functions of the sterility control office would include definition of requirements and the detailing of methods for procedures in the physical plant to ensure sterility in the end product. This would involve the writing of a procedural manual that would consider all steps from the subcontractor to the launch.

Other functions would include personnel training and certification, establishment of surveillance methods such as closed-circuit television, motion pictures, testing procedures, reporting, and inspection.

The audit and acceptance function of the office would require an evaluation of all the work done on the product, and a final judgment on whether or not the product could be called sterile.

● **Voyager**—Considerable effort is going into development of components and techniques applicable to the *Voyager* program as well as to the spacecraft manufacturing process.

A group led by microbiologist James J. Shull has been looking at the problems of setting up the *Voyager* line, including a bioclean assembly facility that would be used for work before the final sterilization phase.

The facility is designed to handle raw materials, components and scientific payload. Of prime importance, Shull said, would be keeping records at each phase, listing all handling from raw materials, storage and manufacture.

If one room, for instance, was found to have a high bioassay, it would be possible to track down what pieces had been in it at that time, and recover them to rectify the error.

Other *Voyager* effort is going toward the choice of sterilizable pyrotechnic devices, design of a high-energy battery, a sterilizable high-shock-resistant relay transmitter and design of digital electronic equipment circuits, to determine which are most suitable for sterilization.

● **Improvement of bioassay**—GE also is seeking to improve its ability to get a correct count of microbial population on spacecraft parts and surfaces.

One device used to evaluate them is a high-speed radioisotope counter. Discs of spacecraft material with different numbers of tagged microbes are placed in the machine to get an accurate count of the population. Various cleaning methods are then used, and counts are again made to assess their efficacy. These can be compared with the results of different methods of bioassay as well.

The counting device also is used for comparing different materials to see how microbial life adheres to them. Tests have been run with aluminum, copper, and stainless steel, and will be used on beryllium, plastics, titanium, glass, and ceramics.

Other GE groups, in a total effort estimated from $700,000 to $1 million, are directing their efforts toward microbiological studies, assay techniques and other aspects of sterilization. ■

Flexible Manned Craft/Booster Urged

Aerojet, Douglas and Air Force press for development of combination to meet rescue and repair needs posed by accelerating space program

by Willard E. Wilks

LIFTOFF of Aerojet-proposed space rescue and service vehicle. Artist's drawing shows version including spacecraft, service module and Titan stage of 260-in. diameter, with 360-in.-dia. solid first-stage motor. This configuration would be 247 ft. long over all. Variation employing 260-in.-dia. first stage would be 300 ft. long. Launch weight of either version would be about 5,100,000 lbs. Payload, in 100-n.-mi. orbit, would be 80,000 lbs. Service module propulsion would provide about 15,000 lbs. thrust.

AIR FORCE, NASA and industry planners are giving growing support to the concept of a multi-purpose combination of a manned spacecraft and a launch vehicle as a next big requirement in space exploration.

Aerojet-General Corp. has begun a series of briefings on its proposal for a space rescue and service vehicle evolving from a company-funded study. Douglas Aircraft Co. is due to report to NASA's Langley Research Center on results to date of a contracted study of a head-end steering concept with multi-mission capabilities.

In connection with its *Manned Orbiting Laboratory (MOL)* program, meanwhile, the Air Force Space Systems Division is studying feasibility of a multi-mission manned system. It is also quietly seeking a program for development of a lifting re-entry spacecraft to replace *Gemini* on the *MOL* canister later in that project.

Both the Aerojet and the Douglas configurations would utilize lifting re-entry spacecraft and big solids. Aerojet is emphasizing state-of-the-art technology.

Government and industry backers cite a number of factors favoring a flexible, multi-mission manned system with quick launch potential. These include the need for a space rescue system arising from the increase in numbers of men being put into orbit, the need for space logistics and orbital servicing and repair, the military requirement for a quick-launched manned system, and the urgency of further developing big-solid rocket technology.

- **Titan plus big solid**—The Aerojet proposal calls for a lifting re-entry vehicle and service module utilizing a *Titan II* with 260-in.-dia. tanks atop a 260-in. or 360-in. solid motor. The service module would be designed for a utility role, carrying equipment and propulsion. The re-entry vehicle, able to carry six or seven men, would represent a payload of 20,000 lbs. Total payload, including service module, would be 80,000 lbs. Service module would carry 37,000 lbs. of storable liquid propellant and an *Apollo*-type ablative engine supplying 15,000 lbs. of thrust and giving a 15-degree orbital-plane change ability.

William C. House, Aerojet vice president for preliminary design, stresses the system's state-of-the-art approach, which, employing *Titan II* and the solid booster, affords substantial cost advantages.

"An important point," House notes, "is that in big-solid technology the fundamentals are 1962 state of the art. I intend to present the facts on how we can arrive at a flight article with a fewer number of tests. We have been more certain of the design, with fewer tests each time we have scaled up in size. We would like to see a feasibility demonstration of this."

- **Head-end advantage**—Key feature of the NASA/Douglas concept, which has progressed from feasibility study to a comparison of its cost-effectiveness with that of other approaches, is its head-end steering. This takes all steering out of the launch vehicle and puts it in the manned spacecraft by equipping the craft with two gimballing storable liquid motors faired into the body.

This eliminates all the interfacing required by conventional steering. The Douglas concept proposes three stages—the lower two consisting of 260-in. solid motors and the third a 156-in. motor. Steering tankage is atop the third stage. The solids supply instant launch capability.

The design centers around logistics and supply associated with a space station, but offers enough mission flexibility to permit rescue and repair flights. ■

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Firms Detail Computer Systems at Fall Show

by Rex Pay

Las Vegas, Nev.—Aerospace systems described at the recent 1965 Fall Joint Computer Conference here included the White Sands Missile Range *Athena* on-line control computer, a Martin Co. digital differential analyzer for re-entry guidance, Lockheed-Georgia's graphics computer, and Grumman Aircraft Engineering Corp.'s hybrid computer system for trajectory simulation for the *Apollo* Lunar Excursion Module.

- **Aerospace graphics**—A significant example of industrial use of on-line computing systems is occurring at Lockheed-Georgia. Operational there since 1964 is a computer graphics facility, using a Univac 418 computer connected to a Digital Equipment Corp. 340 scope with light pen input.

This installation provides three principal projections and a perspective view for drawings in any combination of three views. A conversion to single view, adjustment of that view, and return to four views can be made. Scale can be changed and specific deletions performed. Relative motions can be studied by multiple rotation of axes.

A stored geometric shape can be shaped or molded to fit a preconceived concept or specification. Various geometric tasks in two dimensions—such as constructing tangents or drawing a circle through three points—can be executed. A typical job might be the shaping of an aircraft wheel pod, starting with a circle.

Describing the system, S. H. Chasen said that current emphasis was on the design process, but that structural analysis, management systems, electric circuit layout, and other applications will receive early attention. Tasks to be completed in 1965 are the complete mathematical definition of all surfaces in an aircraft envelope and development of two-dimensional numerical-control milling procedures. Mathematical description will reduce the need for "master models" of such areas as the fillets between C-141 wing and fuselage surfaces. Direct production of milling-machine control tapes from the graphics computer, as drawings are finished on the display scope, is expected to cut tape preparation time by a factor of six.

A new three-scope system to be delivered early in 1966 will be "dedicated to the single but important numerical control application," said Chasen. Equipment for a follow-on man-computer research facility at Lockheed-Georgia is now being evaluated.

Chasen pointed out that this form of computer-aided design makes it possible for specialists to take part in the early design processes. Furthermore, various specialty areas may be linked through their own display systems to a common central computer.

- **Re-entry guidance**—Because the time for solving re-entry guidance equations in lifting re-entry vehicles is extremely limited, the Martin Co. has been investigating digital differential analyzers for this function. Use of shared integrators, automatic rescaling, and a synchronous timing has cut the time required to solve the entire Chapman predictive re-entry guidance equation from entry to impact from 200 to 0.56 secs. Mark W. Goldman of Martin's guidance and control department said that the improved design required less hardware than previous methods and gave the same accuracy.

Goldman said use of logic techniques such as carry look-ahead adders led to add times of 50-90 nanosecs.

To demonstrate the design, a small DDA was fabricated in microelectronics form to solve a simpler equation than the Chapman. Speed and low weight were the main requirements; cost considerations were secondary. Goldman said that the complete flight version of the DDA could be packaged in 0.07 cu. ft. and weigh 3.6 lbs.

- **Athena flight control**—During a 450-mi. *Athena* flight into White Sands Missile Range, an IBM 7044 provides instantaneous impact prediction during first and second stage burn, and computes and transmits guidance corrections to the combined third and fourth stages prior to third-stage ignition. The system then evaluates the telemetered data from the missile and initiates third-stage ignition. It also transmits precise pointing data to eleven tracking and measurement sites, throughout the flight, and operates seven plotter display boards and numerous binary and decimal displays conveying flight-status information.

Describing the system, William G. Davidson, of WSMR Computer Directorate, said that inputs to the *Athena* on-line program are radar-tracking data from five radars, 15 channels of telemetry from the missile, event signals and timing inputs from four sources. To reduce the real-time computer load, a direct data buffering system has been developed to handle many of the computer inputs and outputs. However, the WSMR computer system has recently been upgraded to a direct coupled 7044-7094 and the present *Athena* program is being rewritten. The new program will rely largely on the 7044 side of the system to edit and format data, replacing to a large extent the function of the DDBS.

Future real-time work at WSMR is likely to make greater use of hybrid operations as systems become larger and more complex missile projects appear.

- **Hybrid computing for LEM—** The claim that hybrid computing is the only feasible method to use for Lunar Excursion Module studies was put forward by Arthur Burns of Grumman. The stringent speed and resolution requirements and the complexity of the problem eliminates all-analog or all-digital approaches, he said.

Grumman is using an IBM 7094-II and three consoles of Reeves 500 analog computing equipment. These are connected by an Adage 770 computer link that has 55 digital-to-analog and 48 analog-to-digital channels.

LEM studies of descent and abort missions call for a combination of many subsystems into an integrated simulation, requiring detailed representation of the LEM vehicle. So far the studies have assumed fully-automatic guidance, but a fixed-base, instrumented LEM cockpit, a control and mission console, and external visual displays representing the lunar surface, Command Module, and the stars are being added. Further interface equipment is being included.

High-frequency dynamic equations are assigned to the analog computer. Equations with large dynamic ranges and considerable logic are assigned to the digital machine. For example, the LEM reaction-control system, calculations of body forces and moments, and resulting rotations are handled by the analog computer. This also has descent engine gimballing and reaction-control fuel consumption assigned to it. Translational and trajectory equations, calculations of variable mass and inertias, descent and ascent engine thrusts, and all-axes transformations are placed on the digital computer. This also simulates the on-board guidance computer. ■

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Inorganic Fiber Production Readied

Boron nitride, silicon carbide to be commercially available next October; present facilities able to meet current demand

by John F. Judge

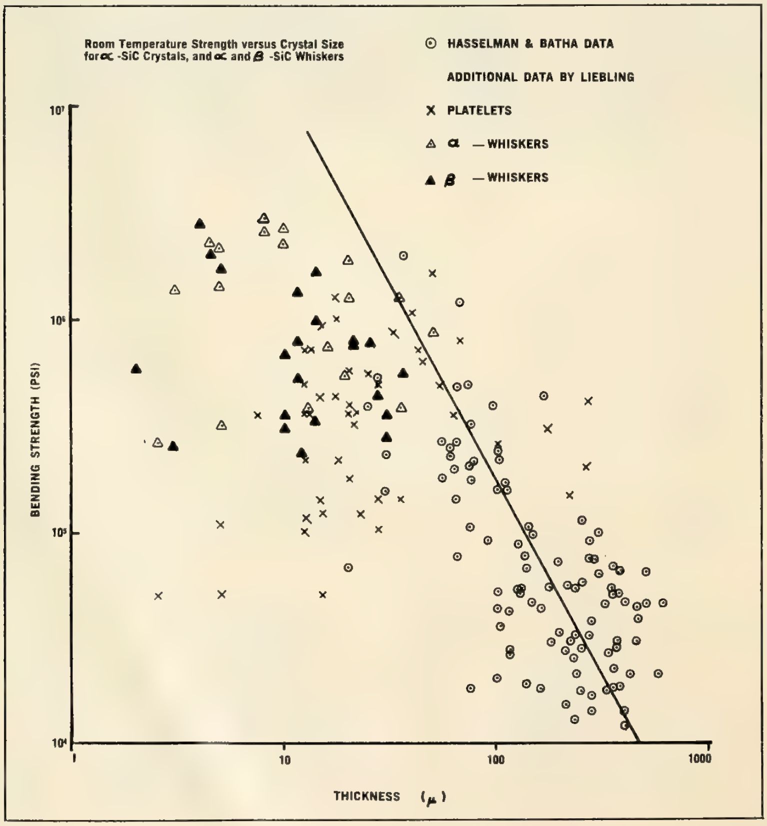
NIAGARA FALLS, N.Y.—Boron nitride fibers and silicon carbide whiskers will soon be produced on a commercial basis by Carborundum Co. The firm is about to start construction of a new fiber plant in the Niagara Falls area. It will be on stream by October, 1966.

Both materials are now in limited production. Company spokesmen say any demand can be met with present facilities. The new plant and the recent acquisition of Basic Carbon, Inc., makes Carborundum a leading contender in the growing market for inorganic fiber and carbon/graphite reinforcements.

Pound-lot prices for both the boron nitride and the silicon carbide materials have dropped sharply over the past year while Carborundum researchers have substantially increased the quality. A significant increase in silicon carbide whisker quality is imminent, but the process details are proprietary. Price will not be affected.

Carborundum's entry into the inorganic fiber field came through the intelligent exploitation of a process malfunction several years ago. From this, the line of Fiberfax ceramic fiber forms was developed into a major segment of the firm's business.

STRENGTH vs. crystal thickness for several forms of SiC. Circles cover three-point bending of hexagonal crystals. Triangles are lab sample whiskers.



Fiberfax spawned research programs into the fundamentals of single crystals and in search for alternate materials and production methods.

- **Boron nitride**—Carborundum has a proprietary process involving the production of boron nitride in the form of fibers. The firm is actively seeking application technology, both in-house and with customers.

The fiber brings all the properties of boron nitride (BN) to a flexible textile raw material. It can, after development, be woven, or used as a reinforcing fiber with a carrier as a route to composites or textile uses. Carborundum experts are not quite convinced that a carrier fiber is an ultimate necessity.

The production material is unique in its combination of properties. No other inorganic material matches it in thermal and electrical properties, combined with its flexible nature in the fiber form.

Research into the BN fibers is now focused on getting the material into textile forms, increasing the modulus and developing continuous filaments.

Property investigations to date indicate that BN fibers possess corrosion resistance and thermal stability superior to any known material. The fibers are currently available only in the form of long staples, 10 to 15 in. long with diameters of 5-7 microns. Both continuous lengths and chopped filament will be marketed in the near future.

Some potential applications include protective clothing, filtration, and high-temperature dust-collection bags. The last use may represent an enormous market since it involves air pollution prevention.

Carborundum moved into the graphite and carbon products field with the acquisition of Basic Carbon, now the Graphite Products Div. of the parent firm.

Graphite Products is best known for its development of Carb-I-Tex, a carbon-reinforced system. Myron T. Cory, president of Graphite Products,

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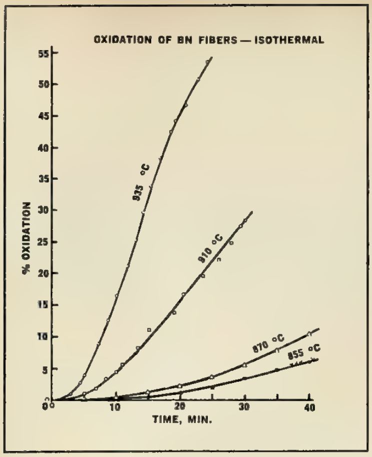


CARBORUNDUM data on oxidation of BN fibers is shown.

says the new material is the result of a proprietary process still being developed with emphasis on improving both the yields and the properties.

Carb-I-Tex is not a raw product. Graphite Products fabricates various shapes in the process to customer specifications. The material is a family of carbon or graphite fibers bonded together with carbon or graphite to achieve strengths and other properties exceeding those of either carbon or graphite by themselves.

Cory says the firm can fabricate shapes up to 39 in. in diameter right now. This capability should extend to 50-in.-dia. shapes by next month. Since the process is still in development, Cory refuses to contract for certain shapes but expects this limitation to be removed in the near future.

- **Process versatile**—There is no theoretical or inherent shape limitation to the process. Various rocket nozzle configurations have been formed by winding or cloth lay-up.

There are no binders in the product; the bond is entirely carbon or graphite. While final shapes can be made directly by Graphite Products, standard blocks that can subsequently be machined by the user are also fabricated.

Carb-I-Tex is 20 times stronger than conventional carbon and is some 30% lighter. It is extremely resistant to both thermal and physical shock. Special properties can be obtained by controlled orientation in fabrication. Thermal conductivity as well as strength increases with increasing temperature—a characteristic of graphite.

Carb-I-Tex can be made in three basic forms: carbon fibers and carbon binder; graphite yarn and carbon binder; and graphite yarn and graphite binder. The strengths are essentially the same. Differences in both electrical and thermal conductivity characterize the groupings.

The division handles the standard solid grades of carbon and graphite as well as yarns. Yarn or fiber manufacture is proprietary with the firm but it is a chemical process. Rayon is the initial material. One process, now in pilot-plant status, converts rayon to full graphitized yarn in less than 20 min. Other processes may take as long as a week.

In addition, there is a silicon carbide coated yarn in development. The coating is abrasion resistant and cuts down oxidation. The silicon-carbide coating can be used with the Carb-I-Tex process with no effect on the ultimate carbon bond.

- **Whisker production**—Carborundum's capacity in silicon carbide whiskers is great enough to supply any and all development projects by any number of customers, the firm says.

The whisker production process itself is a closely guarded company secret, but the quality of production whiskers has improved enormously over the past year. In addition, the firm expects a major boost in production quality early in 1966.

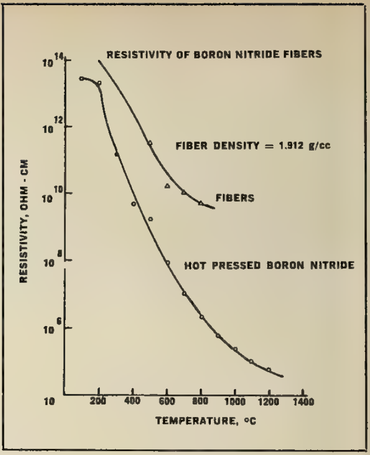
Production is not the problem at Carborundum, says John Z. Stoia, manager, special fibers project in the R&D division. "We are now in a position analogous to that of the glass fiber producers. We have the whiskers. The problem is conversion to useful forms."

The effort at Carborundum is in composites—matching whisker and other fibers to metals, plastics and other matrices. The firm will work closely with customers to develop end items since Carborundum is primarily interested in being a materials supplier for the present.

But Carborundum has been working in composites since its inception in the 1890's. The chief products have been grinding and cutting materials, and these have always been composites—of glass, metals, plastics and ceramics.

- **Applications**—The most obvious applications for whiskers is for the reinforcement and stiffening of metals, plastics, ceramics and glasses. Peter T. B. Shaffer, senior research associate in the research branch, says that phenolic resins have been reinforced to tensile strengths of about 40,000 psi. In another microcrystalline form, silicon carbide flakes have been used to produce epoxy-resin composites with Young's moduli to 10 x 10^6 psi.

Phenolics and epoxy SiC whisker composites have proven to be excellent ablators in preliminary tests. The whiskers do not melt or yield a liquid on decomposition but convert to graphite—another good ablator.



LOWER electrical resistivity of hot-pressed BN is attributed to boron oxide content.

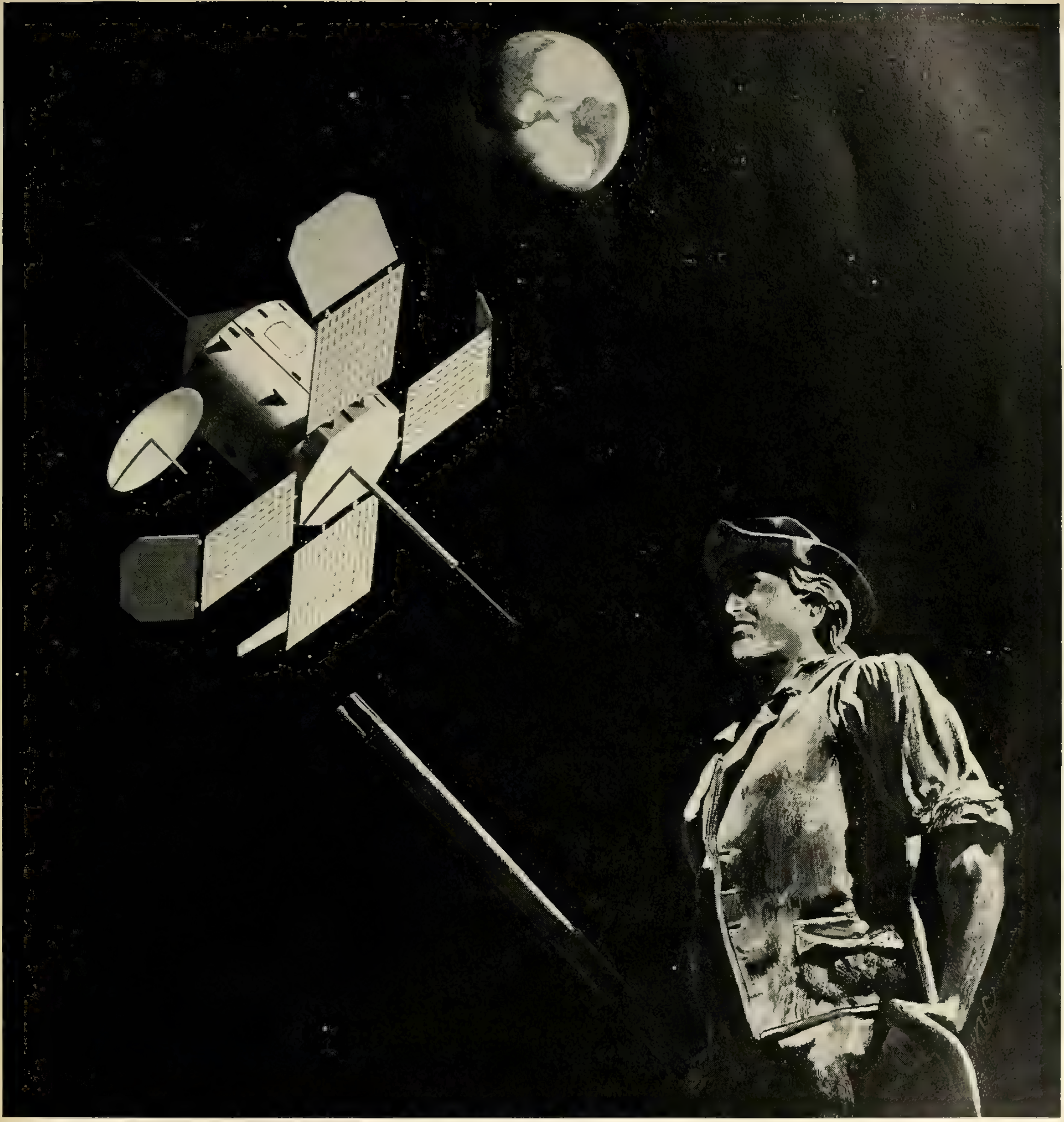
Shaffer says the whiskers could find applications in ternary composites. This involves incorporation of the tiny whiskers in filament-wound structures to give a higher effective matrix and improved interlaminar shear strength. The whiskers would be in the matrix, between the high-strength reinforcing fibers or filaments.

Recent work at Carborundum indicates that the critical aspect ratio (whisker length/diameter) may be on the order of 25 instead of 100. The latter figure would be predicted from the ratio of the elastic moduli. The specific tests in tension have shown no whisker pull-out greater than 20 μ and seldom over 12-15 μ. Shaffer says this may be nothing more than evidence of excellent bonding characteristics instead of a lower critical aspect ratio.

- **Elasticity sought**—Elastic modulus is the major characteristic being sought in composites using SiC or any other whisker. Shaffer says there is now a controversy as to whether the elastic modulus for SiC whiskers is greater than that for microscopic single crystals. Carborundum tests have resulted in the interim acceptance of a value of 70 x 10^6 psi until the whole question is resolved.

The largest single user of Carborundum whiskers is the chemical industry, with aerospace a close second. Carborundum markets the whisker at $250/lb.

Representative end-uses for whisker-reinforced composites include landing gear struts, dental filling, ceramic radome windows, sprayed coatings for semiconductors, ternary glass fiber filament-wound structures, epoxy stamping dies and aluminum reinforcements. Since the whisker itself is opaque to infrared radiation, there is some work going on within the Air Force to use the whiskers in flame- and combustion-detection applications. ■



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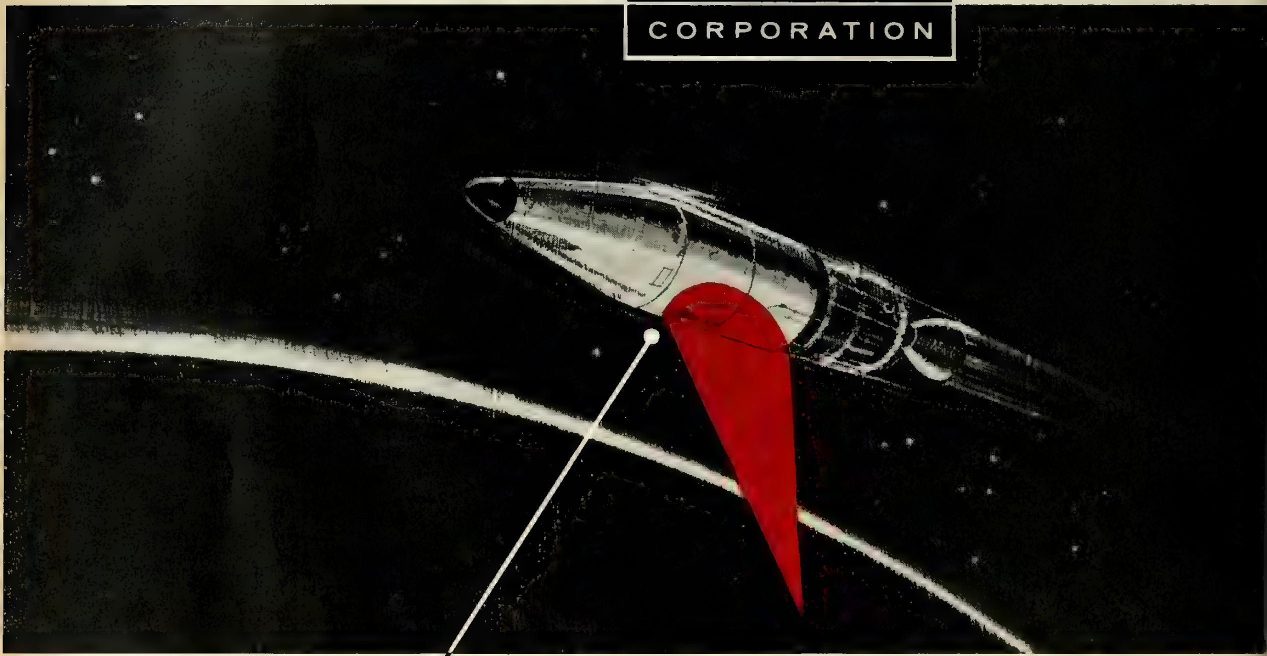


Laser computer systems by Control Data

The Industry Week

U.S. R&D Forecast at $23 Billion

Total U.S. investment in research and development in 1966 is expected to reach a record $23 billion. Economists at Battelle Memorial Institute, Columbus, Ohio, predict that federal R&D spending will rise only slightly but will continue to play a dominant role in the total effort. The shifting nature of government programs is expected to mean greater emphasis on basic research and a wider geographical distribution of R&D, a Battelle spokesman noted.

Mergers and Acquisitions

Vitro Corp. of America, New York City, has acquired major interest in Polytronics Laboratories, Inc., West Caldwell, N.J. The firm will be maintained as a subsidiary of Vitro Corp. with close operating ties with Vitro Electronics Div., Silver Spring, Md. Polytronics manufactures vacuum tube and solid-state radio equipment. . . . *General Technologies Corp., Alexandria, Va., has announced purchase of Thermokinetic Fibers, Inc., Nutley, N.J. Thermokinetic, producer of single-crystal whiskers for materials reinforcement, will be operated as a wholly owned subsidiary.* . . . Electronic Communications, Inc., St. Petersburg, Fla., plans to acquire all voting stock of Scott Electronics Corp., Orlando, Fla. The company will be operated as an ECI subsidiary. Peter L. Scott will continue as president. . . . *Teledyne, Inc., Hawthorne, Calif., has purchased Automated Specialties, Inc., Charlottesville, Va., for more than $1 million.* . . . Magnion, Inc., and Cryonetics Corp., both of Burlington, Mass., have announced plans to merge. A formal plan will be submitted to stockholders later this month. The intended merger would become effective Jan. 1, 1966.

In the Courts

Aerojet-General Corp., El Monte, Calif., has been granted a consent decree against Aero-Jet Products Corp., and Plasti-Kote, Inc., both of Medina, Ohio. The ruling from the U.S. District Court in Cleveland prohibits the two firms from use of the term "Aero-Jet." They are required to destroy all materials containing the word "Aero-Jet" and their trademark registration has been cancelled. Aerojet-General adopted the trademark "Aerojet" in 1942. The two Ohio firms had been using the term since 1959. . . . *Arch C. Scurlock, co-founder and major stockholder of Atlantic Research Corp., Alexandria, Va., will pay the firm $450,000 under a proposed settlement approved in U.S. District Court, Richmond, Va. Scurlock, former ARC president, and Arthur W. Sloan, current president, each signed $500,000 notes in March in settlement of a stockholder suit. (M/R, June 21, p. 43.)*. . . . Ohio Valley Electric Corp. and its subsidiary, Indiana-Kentucky Electric Corp., have announced out-of-court settlements totaling $17,748,000 with General Electric Co. and Westinghouse Electric Corp., representing 11 antitrust damage suits. The litigation was the result of a price-fixing conspiracy uncovered in 1960, based on claims that the two utilities had been overcharged by the firms on purchases of electrical equipment.

International

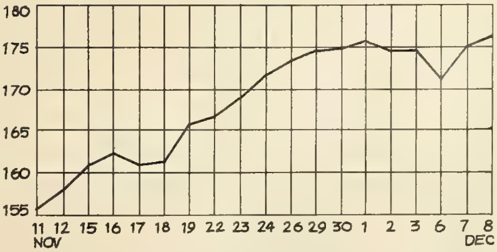
Garlock-Nadella, Inc., has been formed by Garlock, Inc., Palmyra, N.Y., and Nadella S.A., Paris, France. The firm will manufacture needle and plastic-based bearings. Headquarters and production facilities are being planned in the Camden, N.J., area. . . . *Digitronics Corp., Albertson, N.Y., will distribute in the U.S. and its possessions certain data-handling equipment manufactured by N. V. Philips Telecommunicatie Industrie, Hilversum, The Netherlands.* . . . Computing Devices of Canada has dedicated a new Space Sciences Div. at the firm's aerophysics research center near Ottawa. The division will provide applied research and exploratory development and ballistic range testing services.

New Activities

Hercules Powder Co., Wilmington, Del., has created a fibers and film department, replacing its present fibers department. The group will produce and market Herculon olefin fibers and Pro-fax polypropylene film. . . . *3M Co.'s Wollensak plant in Rochester, N.Y., has become part of the Microfilm Products Div. of 3M, St. Paul, Minn.*

Missile/Space Stock Index

Stockholders of Litton Industries, one of 19 firms included in the Missile/Space Stock Index, approved a two-for-one split of common stock, for Jan. 31, increasing the firm's common stock to 39 million shares. Stockholders also approved issuance of a new class of preferred stock. The Index maintained its high level, decreasing only slightly with the announcement of the hike of the Federal Reserve discount rate Dec. 6, and hit a new record of 176.16 by Dec. 8.



100 = CLOSING PRICES OF 19 REPRESENTATIVE AEROSPACE FIRMS DEC. 31, 1964
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$2,625,000—**Philco Corp.**, Philadelphia, Pa., for work on a satellite control network.

$1,600,000—**Avco Corp.**, New York, N.Y., for continued work on *Minuteman* Mark II reentry vehicle in Wilmington, Mass.

$1,206,806—**Sylvania Electric Products, Inc.**, New York, N.Y., for a ground electronics system for *Minuteman* missiles to be produced at Waltham, Mass.

$1,168,000—**General Dynamics Corp.**, San Diego, Calif., for continued anti-missile studies.

$110,000—**Denver Research Institute**, Denver, Colo., to study vibration of aerospace vehicles.

$77,324—**Philco Corp.**, Aeronutronic Div., Newport Beach, Calif., for investigation of thermodynamic properties of rocket combustion products.

$37,496—**Spear, Inc.**, Waltham, Mass., to collect and analyze seismic environmental data of the Kendall Square NASA-Electronics Research Center site for a period of two years.

ARMY

$17,241,177—**Hercules Powder Co.**, Wilmington, Del., for continued production of propellants.

$7,110,378—**Western Electric Co.**, New York, N.Y., for engineering work on *Nike-Hercules* missiles. About 70% of this work will be done by **Western Electric** in Burlington, N.C., 15% by **Douglas Aircraft Co.** in Charlotte, N.C., and 15% by **General Electric Co.** in Syracuse, N.Y.

$1,772,000—**W. R. Grimshaw Construction Co., Inc.**, Houston, Tex., fixed-price contract for construction of the technical services facility at the Manned Spacecraft Center.

$1,243,000—**Research Analysis Corp.**, McLean, Va., for military operations research.

$1,104,852—**Telecomputing Services, Inc.**, Panorama City, Calif., to perform data-reduction services for White Sands Missile Range, N.M.

$557,000—**Cubic Corp.**, San Diego, Calif., for four *SECOR (Sequential Collation of Range)* satellites.

$459,651—**Garrett Corp.**, Research Manufacturing Company Div., El Segundo, Calif., for 18 military gas turbine engine-driven generator sets.

$350,000—**Kaiser Aerospace & Electronics Corp.**, Oakland, Calif., for *Pershing* missile nozzles.

$305,000—**Raytheon Co.**, Andover, Mass., for reconditioning of assemblies for the *Hawk* missile system.

$68,983—**Northrop Corp.**, Anaheim, Calif., for engineering service for *Hawk* loader transport.

$53,410—**Ryan Aeronautical Co.**, San Diego, Calif., for flight service in support of *Firebee* target missile.

Sperry Rand Corp., Great Neck, N.Y., for delivery of a prototype infrared-aimed laser radar system. (Amount not disclosed.)

NAVY

$12,263,103—**Sperry Rand Corp.**, Great Neck, N.Y., letter contract to produce prototype sonar systems.

$6,303,816—**Muncie Gear Co.**, Muncie, Ind., for 2.75-in. rocket components.

$2,701,800—**Farmer Tool Co.**, Denver, Colo., for 2.75-in. rocket components.

$2,509,126—**Honeywell, Inc.**, Minneapolis, Minn., for *Polaris* guidance equipment.

$1,863,000—**Applied Science Industries**, Falls Church, Va., for 2.75-in. rocket components.

$1,165,000—**Admiral Corp.**, Chicago, Ill., for classified electronics equipment.

NASA

$4,400,000—**Telecomputing Services, Inc.**, Panorama City, Calif., two-year contract from Goddard Space Flight Center for on-site data-reduction and computing service.

$953,500—**North American Aviation**, Space and Information Systems Div., Downey, Calif., for work on the paraglider flight test program.

$448,822—**Thiokol Chemical Corp.**, Ogden, Utah, from Goddard Space Flight Center for *Tomahawk* rocket motors and associated hardware.

$358,808—**Bryson Construction Co.**, Decatur, Ala., from Marshall Space Flight Center for a non-destructive test facility for testing rocket materials in simulated space environments.

$192,149—**Adcale Corp.**, Waltham, Mass., from Goddard Space Flight Center for monitor for ultraviolet solar energy instrument. Also $57,851 for solar aspect systems.

$160,273—**Block Engineering, Inc.**, Cambridge, Mass., from Electronics Research Center to develop a device to analyze aerosol particles in the *Apollo* spacecraft.

$121,250—**Textron Electronics, Inc.**, Spectrolab Div., Sylmar, Calif., from Ames Research Center for high intensity radiative heating system for advanced entry heating simulator.

$84,248—**GCA Corp.**, Technology Div., Bedford, Mass., for experimental and theoretical studies in areas of artificial perturbation of the upper atmosphere.

$74,900—**Cornell Aeronautical Lab.**, Buffalo, N.Y., from Goddard Space Flight Center for investigation of premature firing of *Delta* X-258 motor.

$55,555—**General Technologies Corp.**, Alexandria, Va., for research investigation into the properties of various composite materials with the purpose of developing these materials for space vehicle structural applications.

$47,970—**Nuclide Corp.**, State College, Pa., from Goddard Space Flight Center for design and fabrication of high sensitivity mass spectrometer system.

$40,000—**Ohio State University**, Columbus, Ohio, for theoretical and experimental studies of antennas for reflectometer application.

$40,000—**Woodstock College**, Woodstock, Md., for theoretical and experimental studies in planetary and atmospheric physics.

$37,500—**University of California**, Berkeley, Calif., for additional reduction and analysis on *Relay* satellite radiation data.

$36,008—**University of Florida**, Gainesville, Fla., continued support of a receiver for low-frequency radio energy from the planet Jupiter.

$30,000—**Georgia Institute of Technology**, Atlanta, Ga., for studies of heat transfer to a gas containing a cloud of particles.

$30,000—**Harvard University**, Cambridge, Mass., to study human performance in adverse environments.

INDUSTRY

$450,000—**Kaiser Aerospace & Electronics Corp.**, Oakland, Calif., from **Grumman Aircraft Engineering Corp.**, Bethpage, N.Y., for ground-support electronic equipment.

COMMUNICATIONS SATELLITE CORP.

$4,654,000—**Sylvania Electric Products, Inc.**, New York, N.Y., for two large antenna systems to be installed at Earth stations in Hawaii and Washington.

$948,362—**J. P. Finan General Contractor, Inc.**, Honolulu, Hawaii, for site preparation and construction of buildings and other facilities for Earth station at Paumalu, Oahu, Hawaii.

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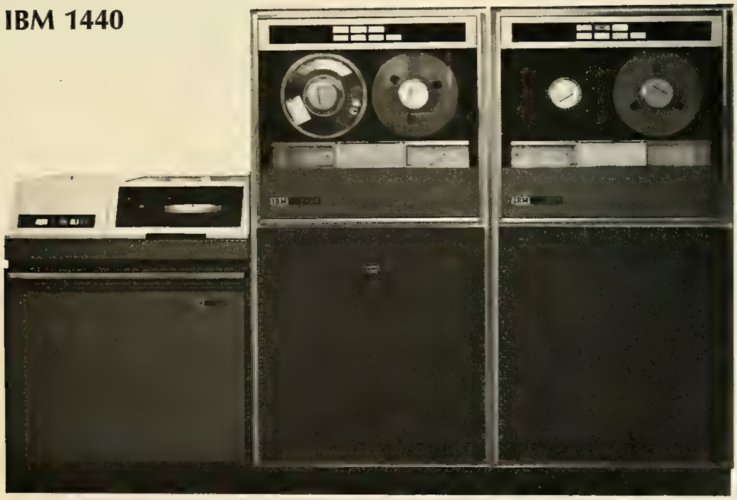
IBM 1440



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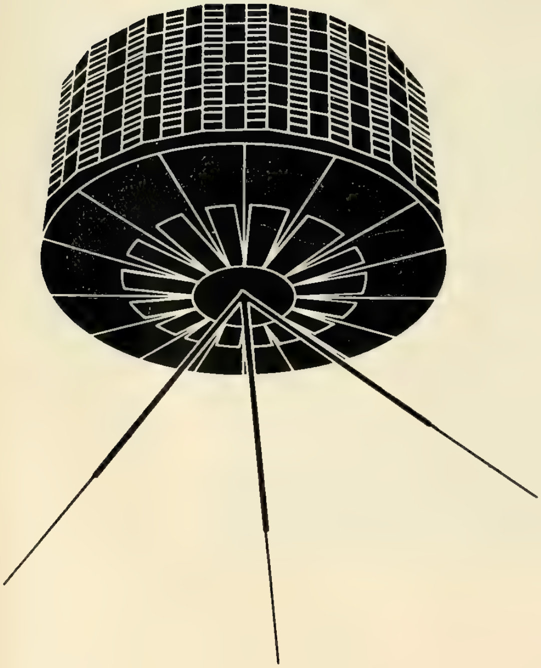
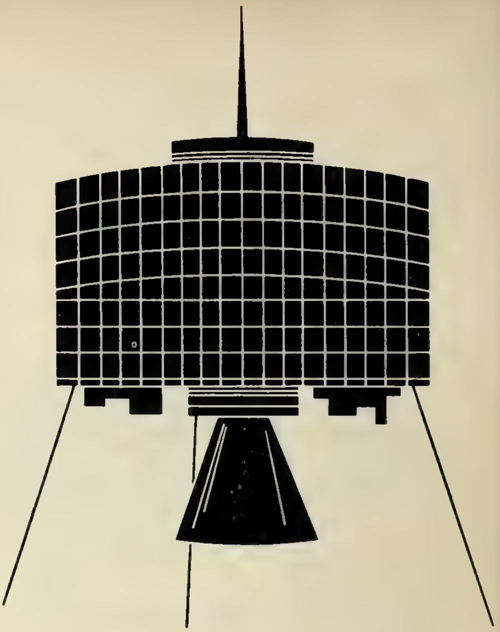
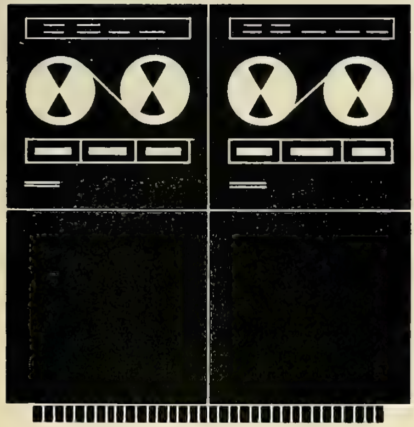
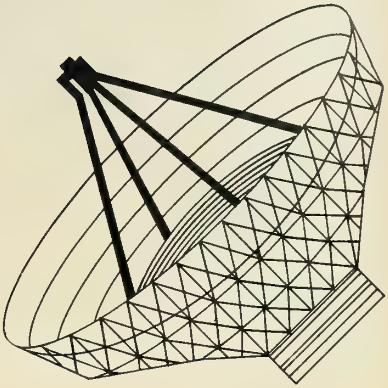




SPACE COMMUNICATIONS





SPACE COMMUNICATIONS

A Special Report on Space Communications will be published by MISSILES AND ROCKETS on January 31, 1966. This report will give comprehensive coverage of the use of advanced satellite systems for military and commercial telecommunications.

Coverage will include today's technical and international problems ☐ global civil communications via satellites and international participation with respect to actually installed or planned terminals with the appropriate systems ☐ all major system components including launch vehicles, satellites, antennas and ground terminals ☐ military satellite communications systems ☐ advanced concepts and techniques that could be employed in future systems in the late 1970's or early '80's.

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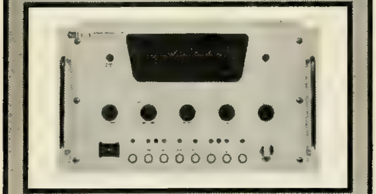

The DEI Bit Error Rate Monitor provides a means of comparing two serial NRZ data bit streams on a bit by bit basis. It accumulates the number of negative or positive comparisons over a bit interval selectable 10^3 to 10^7 bits or on a continuous basis. Provision is made for processing code forms other than NRZ. The number of bit errors (or bit matches) are presented on a visual digital display while simultaneously presented in BCD form as a printer output.

The BA-102 Series can be used in conjunction with PCM serial simulators to measure bit error rate of PCM processing systems. Operation is provided at bit rates from DC to 2 megacycles with data I/O threshold adjustable from +7 to —7 volts.

The power supply is self-contained and input/output connections are provided on both the front and the rear of the unit. A built-in delay to compensate for delay of the processing system under measurement is also provided.

For additional information write for Bulletin BA-102.

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Circle No. 10 on Subscriber Service Card

New Product of the Week: Electronic Controller

An electron beam controller, designed to reduce beam-welding time by up to 50%, has been developed by General Electric Co.

The poly-pattern generator permits generation of various welding patterns ranging in size from a dot to the limit of the welder model. The welding beam is positioned and driven electronically by controlling the X and Y deflection coils. Inertia and backlash are essentially zero, the firm says.

One feature of the device is "modulated puddling," accomplished by spinning the welding beam in a dilating and contracting circle. The technique is believed to reduce weld porosity in difficult-to-weld materials such as Inconel or titanium.

Circle No. 151 on Subscriber Service Card

Gas Analyzer

A mass spectrometer gas analyzer, the Model 610-611, has been announced by Aero Vac Corp.

The device has a mass range of 1 to 500 with unit resolution at mass 130. Partial pressure sensitivity is in the 10^{-13}-torr range for nitrogen. Output may be displayed on an oscilloscope or recorder using one of three scan speeds —1 min., 5 min., or 25 min.

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Synchronous Detection Unit

Teltronics, Inc., has developed a synchronous detection system for use with X-band, K-band and other RF spectrometer bridges without modification to existing instrumentation.

The Model SD-100 provides 1-kc and 100-kc signal processing circuitry for electron paramagnetic resonance and electron spin resonance microwave spectrometer systems. Excitation level is 1 mw to 16 w; excitation impedance level is 0.25 to 400 ohms. Preamplifier sensitivity is —140 db; input impedance is 1,000 ohms and time constant selection is 0.01 to 10 seconds.

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Frequency Extender

A 1 to 2-gc frequency extender, incorporating a tunable four-section YIG preselector, is being marketed by Communication Electronics, Inc.

The Model FE-1-2A converts signals to a 160-mc (or optional 21.4-mc) IF. Use of the preselector provides image rejection of 70 db minimum. Noise figures are typically 16 db, with 18 db maximum.

Input is 115v, 50-400 cps.

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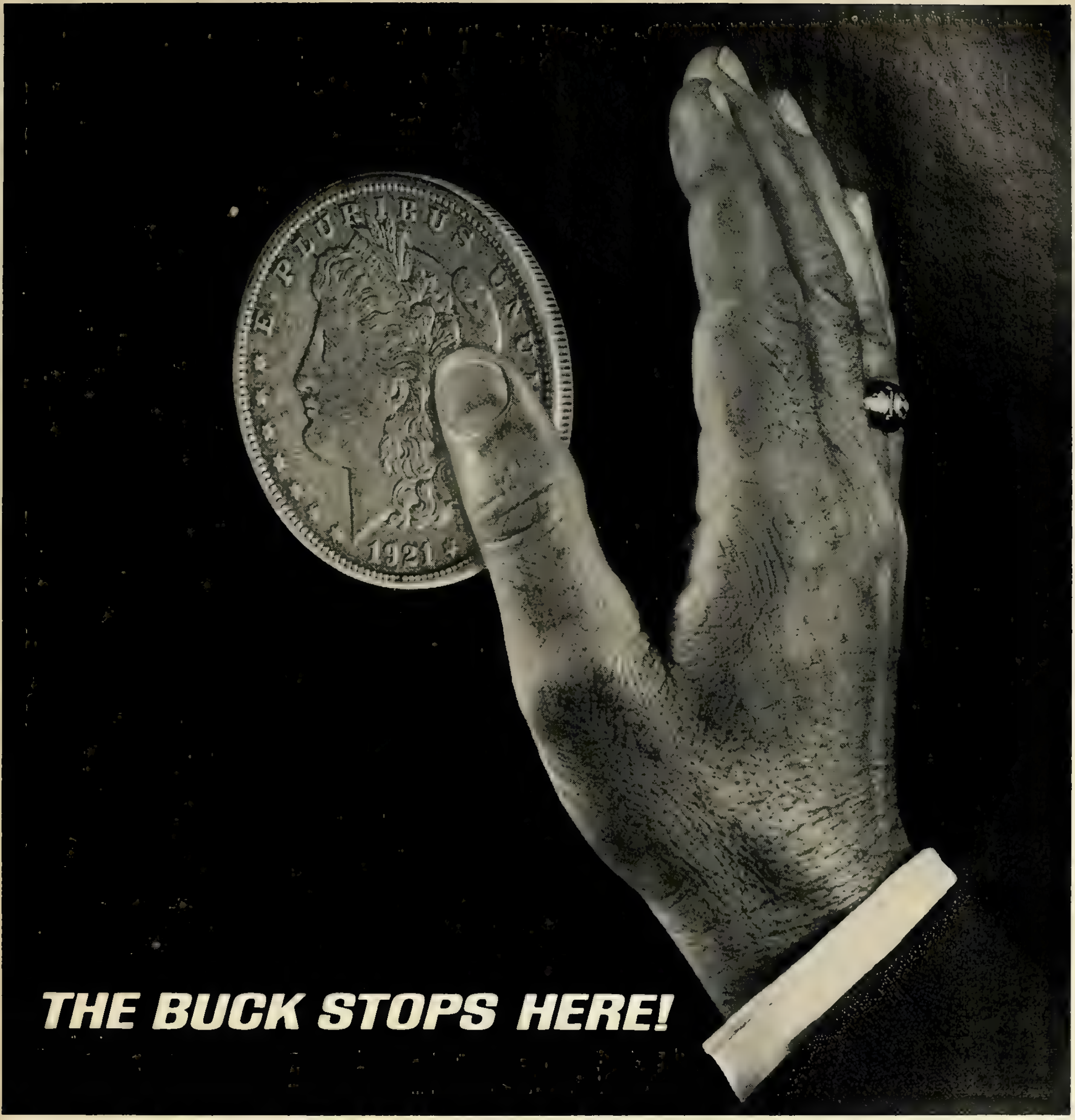

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names in the news

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Irving F. Hazard: Named manager of Inland Testing Laboratories at Cook Electric Co.'s Tech-Center Div. He has been chief engineer at ITL for the past two years.

Wilbur S. Hinman, Jr.: Elected a director of the Bowles Engineering Corp. He was Deputy Assistant Secretary of the Army (Research and Development) at the time of his retirement from government service in 1963.

Dr. Jerome Morenoff: Appointed senior associate at Planning Research Corp.'s Washington, D.C. office. He is assigned to the Intelligence Systems Dept. and will be responsible for the scientific and legal disciplines for areas such as arms control and disarmament.

Gordon O. Sheppard: Elected treasurer of the Memorex Corp. He was previously assistant treasurer.

John G. Hoad: Elected president of the American Institute of Consulting Engineers for 1966. He is president and treasurer of John G. Hoad & Associates, Inc.

S. B. Wendell: Named administrative vice president of McCoy Electronics Co. Also appointed were **David B. Jacoby,** vice president, marketing, and **George K. Bistline,** vice president, engineering.

Edward J. Palmer: Promoted to vice president and general manager of the Mississippi Div. of the American Bosch Arma Corp. He formerly held the position of division manager of the company's Mississippi operation located at Columbus.

Merritt G. Purpus: Elected corporate vice president of Electronic Communications, Inc. He will continue to serve as general manager of ECI's Benson Manufacturing Div. in Kansas City, Mo.

Herbert Harris: Appointed vice president for technical administration and planning of Sperry Gyroscope Co., a division of Sperry Rand Corp. He will be responsible for the administration of the company's independent research and development program and the promotion of engineering practices.

Dr. John L. Kennedy: Appointed to the Research Advisory Committee of System Development Corp. He is professor and chairman of the Dept. of Psychology at Princeton University.

Robert B. Stevenson: Joined the staff of the technology division of GCA Corp. He will be principal scientist in the Systems Research Laboratory, Information Sciences Dept.

Robert P. Fopeano: Named NASA program manager for Scientific Data Systems. He will be the corporate representative for SDS at the Manned Spacecraft Center, Houston, and will coordinate all of the company's business with NASA.

Dr. George H. Bancroft: Named head of the applied physics laboratory at the Bendix Corp.'s Pioneer-Central Div. He will be responsible for directing the laboratory's work in applied research in high-vacuum technology.

Jay G. Levinthal: Joined Raytheon Computer Operation as manager of computer systems development. He will be responsible for all computer systems hardware and software development.

Edwin M. Dexter: Appointed vice president of Bowles Engineering Corp. He will have responsibility for directing all of the firm's engineering operations.

John S. Fondrk: Joined the staff of the Government and Industrial Systems Div., Operations Research Incorporated, as a senior physicist.

Walter Gottesman: Elected to the board of directors of Tenney Engineering, Inc. He joined Tenney in 1952 and became assistant secretary in February, 1959. He has served since the end of that year as secretary.

Capt. Joseph S. Burkle: Appointed deputy director of the Armed Forces Radiobiology Research Institute. The AFRRI investigates the effects of ionizing radiation on biological systems with particular emphasis on better understanding its effect on man.

Robert A. Knisley: Joined the Center for Naval Analyses of The Franklin Institute. He has been assigned to the mathematics and operations research division of the Naval Warfare Analysis Group.

C. Keith Law: Appointed manager, product engineering, for the RCA Communications Systems Div. He was formerly manager of defense planning of the Defense Electronic Products Group at RCA.

missiles and rockets

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Small Business Subcontracting Conference, sponsored by the Small Business Administration, Department of Defense, National Aeronautics & Space Administration, Aerospace Industries Assn., Electronic Industries Assn., National Security Industrial Assn., and the Strategic Industries Assn., Beverly Hilton Hotel, Beverly Hills, Calif., Dec. 15.

Current Topics in Relativity, sponsored by Advanced Research Projects Agency, Pentagon, Room 5A-1070, Washington, D.C., Dec. 16.

132nd Annual Meeting, sponsored by the American Assn., for the Advancement of Science, University of California, Berkeley, Dec. 26-31.

International Symposium on Differential Equations and Theory of Systems, sponsored by the Air Force Office of Aerospace Research, Brown University and the University of Puerto Rico, University of Puerto Rico, Dec. 27-30.

Winter Meeting, sponsored by the National Society of Professional Engineers, Americana Hotel, Miami Beach, Fla., Jan. 5-8.

American Chemical Society National Winter Meeting, Phoenix, Ariz., Jan. 16-21.

Society of Plastics Engineers Regional Technology Conference, sponsored by the Cleveland Section, Sheraton-Cleveland Hotel, Cleveland, Jan. 20.

Third Coral Gables Conference on Symmetry Principles at High Energy, sponsored by the University of Miami, Air Force Office of Scientific Research, Atomic Energy Commission, National Aeronautics & Space Administration, National Science Foundation, and Office of Naval Research, University of Miami, Coral Gables, Fla., Jan. 20-22.

Third Aerospace Sciences Meeting, sponsored by the American Institute of Aeronautics & Astronautics, New York City, Jan. 24-26.

National Symposium on Tests for Fire Resistance of Hydraulic Fluids and Lubricants, sponsored by the American Society for Testing and Materials, Jung Hotel, New Orleans, La., Jan. 24-25.

Symposium on Electrification of Machinery, sponsored by the Institute of Electrical & Electronics Engineers, Worcester Section, Wachesett Country Club, West Boylston, Mass., Jan. 25.

Engineering & Operations Workshop, sponsored by the American Public Power Assn., Roosevelt Hotel, New Orleans, La., Jan. 25-28.

1966 Annual Symposium on Reliability, co-sponsored by the American Society for Quality Control, Institute of Electrical and Electronics Engineers Reliability Group, the Institute of Environmental Sciences, and the Society for Nondestructive Testing, Sheraton-Palace Hotel, San Francisco, Calif., Jan. 25-27.

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The Man from Pocomoke City

WHEN MR. JAMES E. WEBB took over as Administrator of the National Aeronautics and Space Administration almost four years ago, no one was more aware than he that the agency was a house divided.

Many of the scientists and engineers in the space agency were disgruntled at the selection of an administrator rather than a scientist to head the organization.

The creditable job NASA has done in a period of explosive growth is a tribute not only to Mr. Webb but to the man who might, under slightly different circumstances, have been named Administrator instead.

Dr. Hugh Latimer Dryden, deputy administrator of NASA, lost his long battle with cancer this month. The fact that his passing will be a severe loss to the man he worked for speaks worlds of the role Dr. Dryden filled at NASA.

Refusing to play the game of those who wanted to continue the fight for a scientific administrator, he went to work with a will to assure the successful development of a national space program and of the space agency itself.

It was a critical period for NASA. The organization had not yet outgrown the clubby in-group atmosphere of the old National Advisory Committee for Aeronautics, which was its predecessor. It had to contend with the major internal adjustments inherent in a massive personnel increase while also meeting the challenge of the new manned lunar landing program.

Through it all, the quiet, bespectacled man known to his colleagues by the affectionate nickname "The Old Warhorse" never lost the attitude of calm, scientific appraisal which made him invaluable to the agency. He was gifted not only with the ability to understand the intricacies of the space program in detail but with the vision to see the promise of space technology for the years ahead.

Even knowledge of his fatal illness failed to slow him down.

John Rhea, NASA editor for our sister publication, *Missile/Space Daily*, remembers him this way:

"He had time for everyone. He received a steady stream of visitors when he could be in his office. He tried to answer even the most foolish questions and talked confidently of future strides in space that he knew he would never see . . . A small, frail man in his last years, Dr. Dryden seemed out of place in his huge office on top of the NASA headquarters building in Washington. His voice was almost a whisper as he spoke at length—without ever looking at any material—of the complex details of space programs. He didn't shoo visitors out of his office even though it had become a chore to continue long conversations."

It is fitting that Mr. Rhea's obituary of Dr. Dryden was filed from Cape Kennedy, where he was covering the *Gemini 7* launch. The NASA deputy administrator had much to do with the success of both the *Mercury* and *Gemini* programs.

Born in Pocomoke City, Md., in 1898, Dr. Dryden began his career at the National Bureau of Standards in Washington, where he was an inspector of munitions gages. He was with NBS until 1947, rising to associate director. He then joined NACA, becoming director of that organization in 1949.

He played a major role in the organization of NASA, and President Eisenhower named him deputy administrator of the new agency in 1958, the post he held until his death.

Writing in 1961 about the appointment of Mr. Webb as NASA Administrator, we said: "He told a visitor to his office last week he does not feel his job is to tell NASA's scientific staff in detail what to do, but to create an atmosphere of creativity in which scientific work and innovation can flourish."

JUST HOW LARGE A PART Dr. Dryden played in creating that atmosphere was evident in Mr. Webb's own tribute to his deputy last week: "Dr. Dryden was a man of his time, of the air age, of the nuclear age, of the space age, with all the implications of modern science and technology for the accomplishments of his time. He was also a man for all times because his courage in understanding the conquest of air and space, his scientific, engineering and administrative competence and his qualities of humanity and leadership mark him as one of the truly great men who have contributed over the years to these fields. He will be sorely missed in NASA, in the nation, and indeed, in many nations."

Writing in MISSILES AND ROCKETS a few years ago, Dr. Dryden saw clearly the benefits space technology held for the U.S. economy, but his vision was of something even greater:

"While the technological developments offer the earliest contributions to the economic development, in the long run the contributions from the scientific knowledge obtained in the great unknown environment of interplanetary space may bring much greater returns, perhaps far beyond what man at this time could possibly envision."

Of his own career, Dr. Dryden once recalled: "The airplane and I grew up together. I saw my first airplane, the Antoinette airplane, flown by Hubert Latham in Baltimore on Nov. 7, 1910 . . . I have had the good fortune to be associated with the great growth in aviation from that primitive vehicle to the jet liners of today and our beginning manned space flights of *Mercury* and *Gemini*. My education has been a continuing process ever since graduation and I hope that I may have the good fortune to witness the first landing of men on the Moon within a very few years."

He was not granted that good fortune. But the men who set foot on the Moon will owe much to Hugh Latimer Dryden.

William J. Coughlin

Our Armed Forces in Southeast Asia and in other corners of the world are now using the AN/TRC-80, originally designed for use with the Pershing Missile System, for point-to-point tactical communications. It provides one duplex voice channel and one half-duplex teletype channel. It can be put into full operation by a two-man crew within 10 minutes of its arrival by helicopter or land transport.

Varian Klystrons Still Operating in Southeast Asia as of August 26, 1965

SERIAL NO.	OPERATING HRS.	SERIAL NO.	OPERATING HRS.
1564	7,290	1051	16,447
1225	20,520	1572	14,786
1371	5,278	1291	14,044
1039	22,798	1101	17,251
1097	20,286	1582	18,064
1230	5,890	1515	11,281
1014	11,233	1506	11,658
1585	10,288	1393	3,909
1229	4,368	1522	9,160
1087	22,630	1440	10,092
1103	6,920	1352	8,394
1211	20,400	1402	6,224
1092	19,820	1373	11,791

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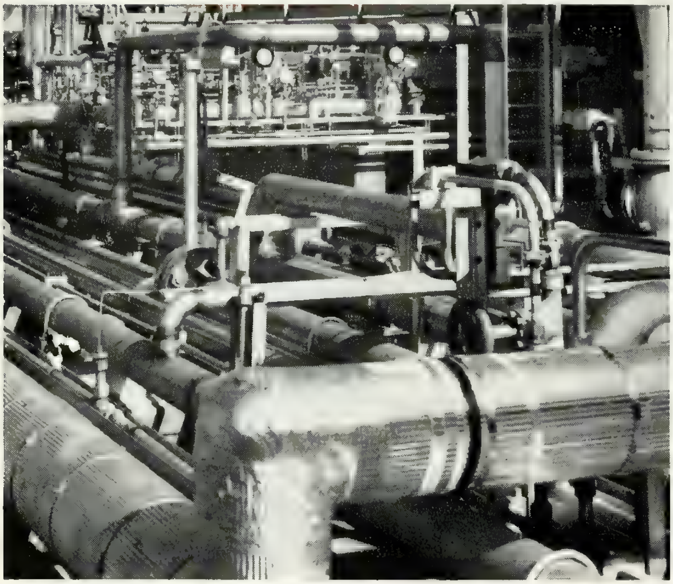

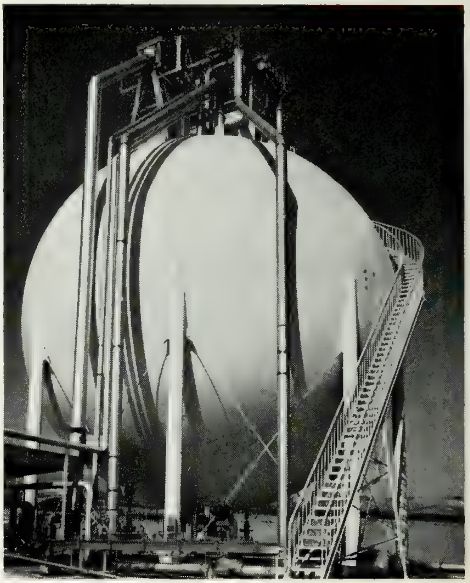

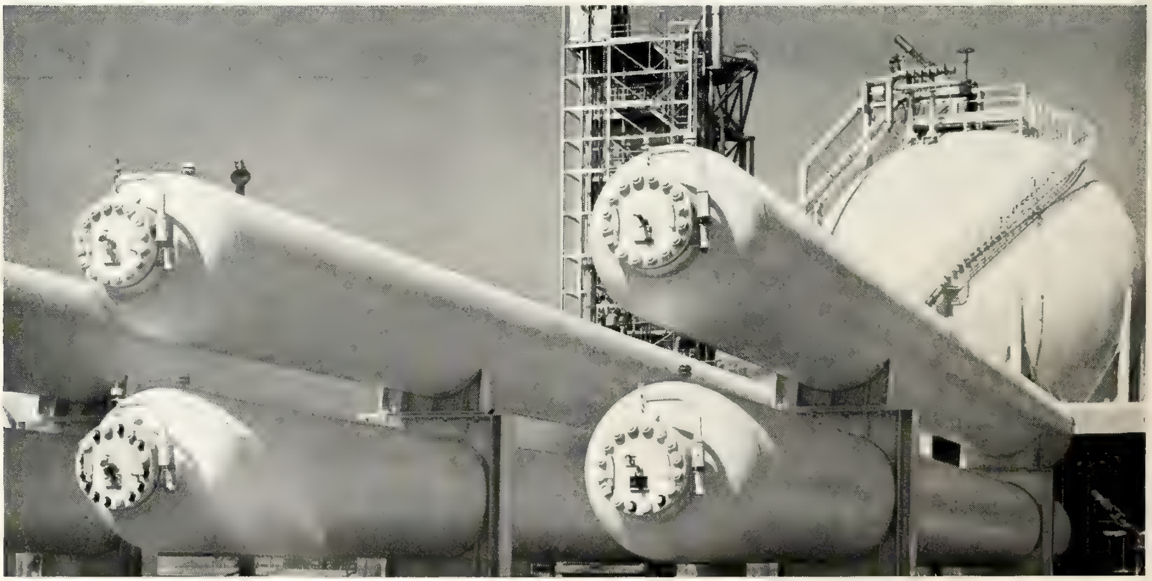

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missiles and rockets

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Implications of Gemini 7/6 Success

TRW Wins Comsat Corp. Competition

Data Indicates Loose Lunar Surface

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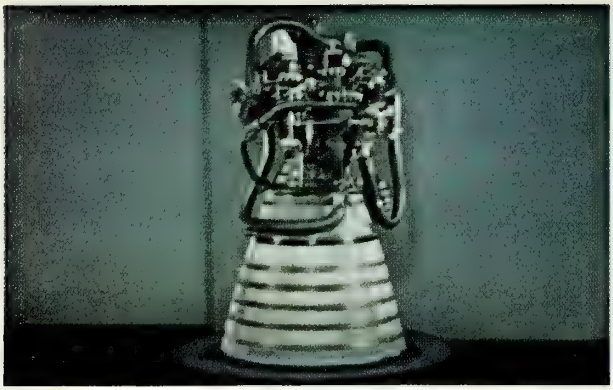
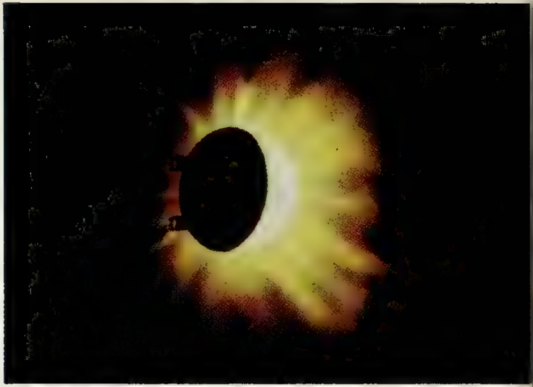
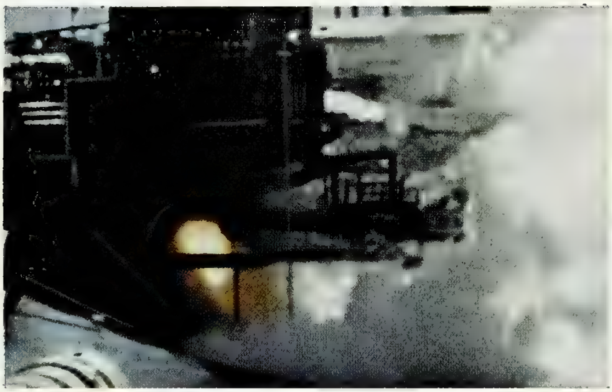
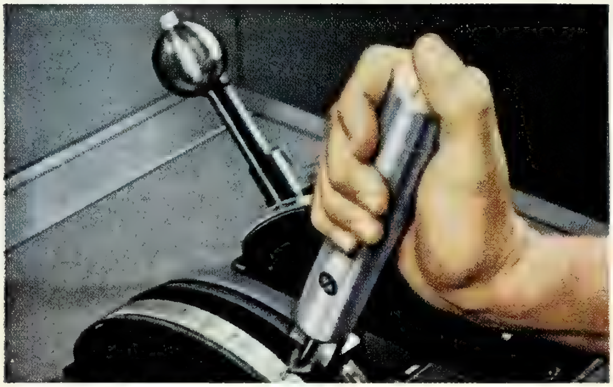
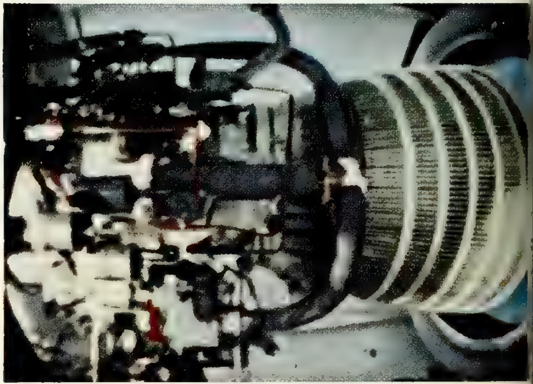

OCTOBER 1958: Design began on the RL10, first liquid hydrogen rocket engine.

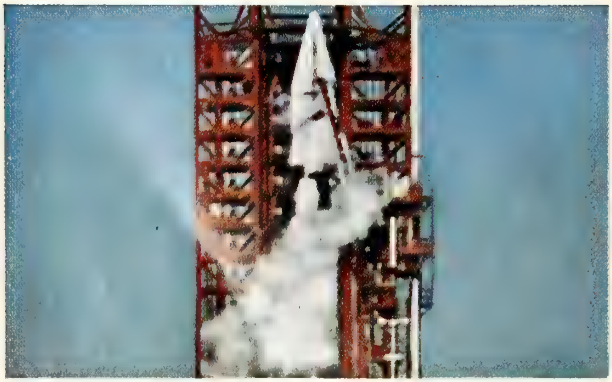

JULY 1959: First RL10 fired.

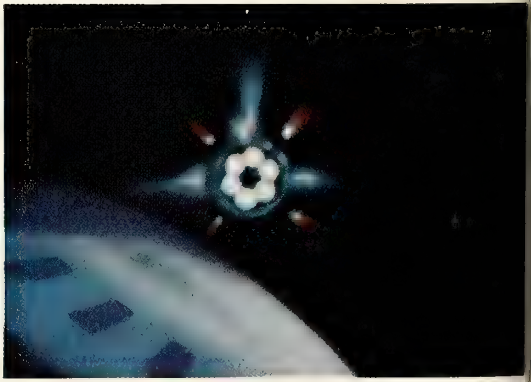

MARCH 1962: Static firing of first Centaur test vehicle, powered by two RL10s.

AUGUST 1962: Static firing of Saturn S-IV stage, powered by six RL10s.


SEPTEMBER 1962: RL10 throttleability demonstrated.


JUNE 1963: RL10 instant stop-start capability demonstrated.


NOVEMBER 1963: RL10s power first Centaur vehicle in orbit.


JANUARY 1964: RL10s power first Saturn S-IV vehicle in orbit.

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Facilities—The RL10 was engineered at the Florida Research and Development Center of Pratt & Whitney Aircraft. This Center, one of the nation's most advanced for research and development in high-energy liquid rocket engines, includes a broad spectrum of component and engine test facilities.

Success—Pratt & Whitney Aircraft has demonstrated the ability to deliver reliable rocket engines. The liquid hydrogen RL10 performed flawlessly in all its 44 NASA space firings, while proving itself as the Free World's highest-performance rocket engine.

Pratt & Whitney Aircraft is ready today to meet tomorrow's propulsion requirements.

Pratt & Whitney Aircraft DIVISION OF UNITED AIRCRAFT CORPORATION
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In subsonic airborne systems, Lockheed is taking a fresh look at basic problems. For example, it is deeply involved in STOL and V/STOL short-haul transports for mass travel between major cities. In addition, a Lockheed five passenger rigid rotor helicopter prototype is now flying. In the future: heavy-lift helicopters capable of transporting 24,000 or 40,000 pounds for 100 or 200 miles. And under parallel development—advanced rotary-wing craft able to stop, fold, or start blades in forward flight.

Lockheed's supersonic efforts are also expanding. Its SST program alone is a major and growing endeavor. It reflects the unprecedented experience Lockheed engineers have gained in Mach 3, high altitude, titanium aircraft.

Manned hypersonic test and cruise vehicles, using the SCRAMJET approach, are under development at Lockheed. They point to the day when high priority passengers and cargo can travel at Mach 12 speeds to any place on earth.

A large number of engineering positions are now open in sub-, super-, and hypersonic speed efforts. For information concerning specific opportunities write: Mr. E. W. Des Lauriers, Professional Placement Manager, Dept 1712, 2405 N. Hollywood Way, Burbank, California. An equal opportunity employer.

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THE WEEKLY OF ADVANCED TECHNOLOGY

Volume 17, Number 25 December 20, 1965

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THE COVER

Astronaut Walter Schirra indicates satisfaction with Gemini 6 mission just after spacecraft hatch was opened aboard USS Wasp. Schirra and pilot Thomas Stafford teamed with Gemini 7 Astronauts Frank Borman and James Lovell Dec. 15 in history's first space rendezvous. See p. 15.

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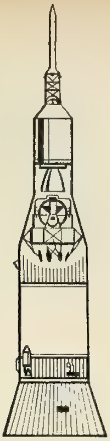
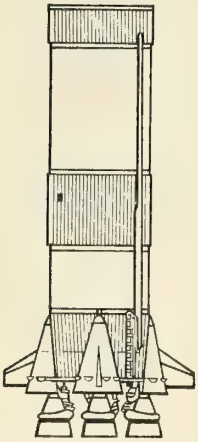
Season's Greetings—The Editors



Take part in thinking through Project Apollo



Bellcomm's scientists and engineers have collectively thought their ways to the moon and back many times—and they will do it countless more times.

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letters

Lunar Surface Muffling?

To the Editor:

The current failure of the Soviet spacecraft *Luna 8* to complete a soft landing on the surface of the Moon following three previous attempts (*Luna 5, 6 & 7*) this year warrants immediate and specific attention not only by the directors of the Soviet lunar program (which, needless to say, I am certain will occur) but also by Mr. (NASA Administrator James E.) Webb & Co. for the U.S. lunar program.

We cannot but agree that the Soviet lunar spacecraft must be quite sophisticated both in design and operation. One might—and should—measure such sophistication by their previous successes in Earth orbit, by the probe *Zond 3*, and by the large weights of the *Luna* series of spacecraft.

What, then, went wrong? I would like to speculate that perhaps little or nothing with the Soviet spacecraft. The fault appears to lie in our own distinct lack of knowledge of the lunar surface, the beautiful *Ranger* photographs notwithstanding. I should like to hazard the guess that what we have seen in the *Ranger* photographs is the pulverized surface of the "fairy castle" (cotton candy) theory suggested in recent literature. If, indeed, the upper few inches of the fairy castle structure has been pulverized by meteoroid strikes and underlying this is several yards of this very-low-density structure, then we might expect that a vehicle attempting a soft landing would, no matter how accurate its instrumentation and propulsion systems, cause the surface to fail and then be covered by debris to a depth of several yards. The dielectric constant of the debris would prevent even battery-powered communications from taking place, since the effective wavelength radiated by any antennas aboard would be distorted beyond usefulness.

Because this type of speculation is plausible, it warrants further inquiry. I would suggest to both the Soviet Union and the U.S.A. that attempts be made at the earliest possible time to land a *simple* lightweight radio beacon—with a power supply not to exceed one week of service—so that we can ascertain whether or not the lunar surface will support such a "probe," which would be easily evidenced by hearing its radio beacon.

Saunders B. Kramer
Fellow, British Interplanetary Society
Mountain View, Calif.

Over the Line

To the Editor:

I recently resubscribed to your magazine for another three years. Please cancel my subscription. Your "Editorial" in the Dec. 6 issue ("Hogwash Conference") has gone over the line of sanity. I henceforth refuse to support you paranoids who can see importance in nothing but maintaining the present power structure.

In the uncertain future, one thing is inevitable. When nuclear proliferation has continued past the point of all safety measures, a nuclear "accident" will occur. If we're lucky enough to 1) not have it escalate, and 2) not to have been in the vicinity of the accident, we will see an awakening to the fact that "defense" has long since passed the point of diminishing returns.

In a sense, it's a shame that the accident hasn't already happened. We might now be directing our industrial resources toward survival. Maybe even M/R's Editor might then be respectful of eminent men of science—or better yet, out of a job.

V. L. Coffield
Los Angeles

To the Editor:

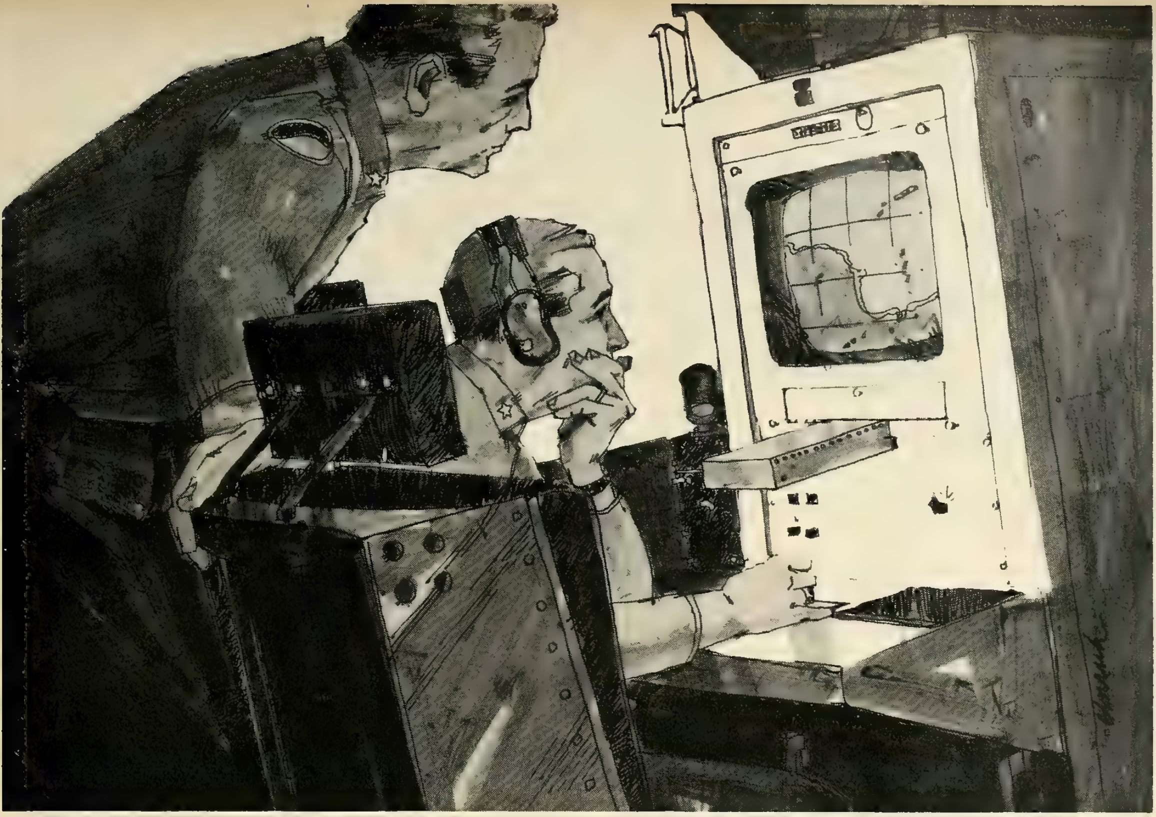
Your editorial is excellent, and has pointed out only one more of the subversive actions emanating from Washington. Knowingly or unknowingly—I cannot say which—our government is allowing professional appeasers, Communist sympathizers and/or Moscow/Peking-oriented (-trained?) intellectuals to influence our domestic and foreign policies—especially our policies toward the Soviet Union.

The American public is, and has been for years, under constant bombardment by news propaganda that tries (and is succeeding) to make the Russians appear to be "the good guys with the white hats." Now, the *New York Times* and the *Washington Post*—probably controlled news media—blurt the same line of ridiculous propaganda to the Nation to continue the softening up of the masses with the constant thought that "war is unthinkable." Such thought control leads to national indifference. Such indifference leads to ease of controlled elections. Controlled elections give us the men we think we put into office by *popular* vote.

Brainwashing the gullible masses then becomes a fairly easy task. The major news media are fed those "news" items which contain the dynamite of subtle thought—the formula for eventual capitulation contained therein: "Don't worry about the future or Communism—let the government handle all your problems." On the opposite hand, these subversives influence our policies through well-meaning, but gullible, "do gooders" such that disarmament becomes a humanitarian act whether it leaves us protected or not. Then the international conspiracy forces the issues of aggression and we find ourselves bankrupting ourselves through foreign aid, financing other nations' wars, thus gearing our economy to war.

We find ourselves in a dilemma: 1) Disarm! 2) Fight! If we disarm, what happens? 1) We cannot fight back when the enemy, who does not intend to disarm, attacks us. 2) Our economy collapses (for we must now remain on a war footing to avoid a disastrous depression). The trumpets of disarmament are not in harmony with the true intent.

E. F. Van Nostrand
Edgewood, Md.



Your Move, General

And how much faster and more accurately those vital battle decisions can be made with ABC^3 — the sophisticated Airborne Battlefield Command and Control Center produced by LTV Electrosystems. ▪ A self-contained unit that is operational either from the air or on the ground, ABC^3 — or "Head Shed" as it's called by combat troops — is an advanced weapons system that permits battle commanders of joint services and their staffs to conduct complete combat operations in a "see-for-yourself" situation. Essentially, ABC^3 works this way: (1) through the use of sensor aircraft and television, SLR (side looking radar), infrared and photographic devices, ABC^3 reconstructs reconnaissance information and provides it for near-real time display at command stations; (2) through HF, VHF and UHF, battle commanders communicate with and control all strike forces — air, sea and ground — for total and maximum effectiveness. ▪ Put more simply, ABC^3 permits battle commanders to view on television screens battle as it takes place, know exactly what the enemy is doing, make moves and counter moves, and have complete communications with all forces. ▪ The first such system of its kind, ABC^3 was produced and delivered to the Air Force from scratch in 98 days by LTV Electrosystems — well within the cost and time limitations of its contract. This vitally needed system is available for production in quantity immediately.

ABC^3 represents only one phase of the vast military electronics capability available from LTV Electrosystems. Through expansion LTV Electrosystems has broadened its base considerably and today provides one central source for total capability in the field of military electronics. ▪ Through its two divisions — Greenville and Garland — and its subsidiary — Continental Electronics — it has the experience, knowledge, facilities and resources to conceive, design, engineer, manage, manufacture, test and deliver high quality defense, space and electronic systems and associated equipment from prototype to long-production-run quantities. ▪ LTV Electrosystems, Inc. / Greenville, Texas / A Subsidiary of Ling-Temco-Vought, Inc.

LTV

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With our traffic, we sometimes wonder what the neighbors will think.

Monkeys, astronauts, telescopes, sea urchin eggs and tradescantia come in the front door. Weather satellites, orbiting observatories, ballistic re-entry systems, manned orbiting labs, biosatellites, space taxis and space buses go out the back. Mark 2 and other vintage re-entry systems are in the Smithsonian (we're now developing advanced ballistic and return-from-orbit re-entry systems). Nimbus flew out of our Valley Forge space simulators a year ago and faced the world. At one extreme we built a 15-part Gravity Gradient Stabilization System which is still operating within 4½ degrees of arc. At the other, our 22,000 part control system for OAO will soon have its chance to hurtle a Mt. Palomar through space.

Biosatellite with its lively "crew" is slated for several round-trips soon. MOL and its astronauts will see the countdown a couple of years later (recently selected as a prime contractor). We're studying unmanned exploration of Mars (Voyager). Our SNAP 27 will be the first nuclear power system to hit the moon.

And we have a lot of ambitions that are yet ideas. Space shuttles and space station taxis, for example. No wonder our engineers always buckle down (their own test benches may go up next).

Are you interested in IR/optics, simulation, human factors, life support, radar discrimination, structures and weights, reliability, guidance & control, measurements and environments, materials development, spacecraft design, experiment integration and installation, structural mechanics, aerodynamics, thermodynamics, flight systems analysis, electrochemistry, flight mechanics, operations research, fluid mechanics, arming & fuzing, nuclear power (SNAP 27). Write to Mr. J. S. Barson, Dept. 394M-3, Space Technology Center, General Electric Co., P.O. Box 8555, Philadelphia, Pa.

MISSILE & SPACE DIVISION

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The Countdown

WASHINGTON

MOL Selections Made

Air Force sources close to the *Manned Orbiting Laboratory* project tell COUNTDOWN that Collins Radio Co. and Honeywell, Inc., have been selected as subsystem contractors for the communications and attitude-control assignments. Still undecided, the same sources report, are the competitions for the data-management subsystem and the fuel-cell power supply.

DOD Budget Above $57 Billion Forecast

Congressional sources estimate the Dept. of Defense budget request, due on Capitol Hill Jan. 24, will be between $57 billion and $60 billion, with the exact amount to depend on the size of a supplemental to FY 1966 funds, which also will be requested. Secretary of Defense Robert S. McNamara is expected to ask for $5-7.5 billion for the supplemental. Either way, it adds up to about $65 billion in new funds.

How To Do Business in the Middle East . . .

First, you sell a missile system to Israel, as the U.S. has done with Raytheon's *Hawk* surface-to-air weapon. Next, you wait for sales to the Arab nations. First Arab nation expected to come across with what is estimated as a $100-million buy is Saudi Arabia, as predicted by COUNTDOWN last year (July 6, 1964, p. 7). Discussions also are believed to be under way with Iran, Iraq, Jordan and Lebanon involving a variety of air-defense systems—some being proposed by the British but all believed to involve the *Hawk*.

. . . And in Western Europe

Raytheon also will be the beneficiary in a new agreement between the U.S. and the Italian Ministry of Defense for joint production of a new version of the Lockheed F-104 fighter, to be known as the F-104S. The fighter is specifically designed to carry Raytheon's *Sparrow III* air-to-air missile. Sale of *Sparrow* to the Italians was also anticipated by COUNTDOWN (Nov. 1, p. 7). Sources close to the project say the Italians will get the "NATO version" of the *Sparrow III-6B*, nearly identical in performance with the most advanced model in the U.S. inventory. There are believed to be some differences in the countermeasures area.

NASA Budget Is in Trouble

Although a final Fiscal 1967 budget figure for NASA has not yet emerged from talks between the Budget Bureau and the space agency, reports persist that the former is holding firm for a funding level below $5.2 billion. If this is true, NASA may have to decide whether to delay either *Apollo Applications* or Project *Voyager* for at least a year. The 260-inch solid motor project also is in serious difficulty. NASA already has announced cancellation of the *Advanced Orbiting Solar Observatory* for budgetary reasons.

DOD Reveals China Estimates

Secretary of Defense McNamara has given NATO some estimates on the nuclear weapons plans of the Communist Chinese. The Secretary, according to a spokesman, told NATO Ministers in Paris last week that the Chinese will have a small stockpile of nuclear weapons—and probably a medium-range ballistic missile system to deliver them—by 1967. He said the Chinese would probably develop and deploy intercontinental-range weapons able to reach both the U.S. and Western Europe by 1975.

Man Bites Dog? Snow Job Hits Air Force

U.S. Air Force planned to use its optical satellite surveillance station, located atop a 9,000-ft. mountain just outside of Cloudcroft, N.M. to track and photograph the *Gemini* rendezvous last week. Things went awry when the telescope site, chosen because of generally excellent visibility, was clobbered by a substantial snow storm.

INDUSTRY

Vietnam May Slow MOL

Metal-working firms capable of handling the *Manned Orbiting Laboratory* total system components requirements are rapidly being swamped with business generated by the expanding effort in Vietnam. The commercial boom also is a factor. Lead-time stretch-out imposed by *MOL* budget and technical decision delays could result in an industrial inability to respond to an *MOL* effort in the near future. Firms now involved with launch-vehicle hardware components for the *MOL* booster are fighting to keep their facilities from being shifted to other programs.

WTR Titan III Sites Progress

Air Force officers say modification of the *Atlas-Agena* launch pad at Vandenberg AFB to handle the *Titan III-B* launch vehicle now is essentially completed. They also report that design studies on the new *Titan III-C* launch facilities for the West Coast test site have just been completed.

Biggest Solid Readied for Firing

Aerojet-General is preparing for a St. Valentine's Day static test-firing of its second half-length 260-inch solid rocket motor at the firm's Dade Div. plant near Homestead, Fla. Slight changes, based on the extra hot burn experienced in the successful first firing Sept. 25, are being made in the motor. Insulation on the walls, for example, has been thickened from 0.2 to 0.3 inches. First motor developed 3.57 million lbs. of thrust instead of the anticipated 3.2 million lbs. The higher figure is the target thrust for the Feb. 14 firing.

INTERNATIONAL

U.S. Ships Nike-Ajax to Japan

U.S. is flying 36 *Nike-Ajax* surface-to-air missiles with launchers to the Japanese Air Self-Defense Force's three air bases on Japan's southernmost island of Kyushu. More than 300 ASDF men to man the missile sites are training at military facilities in the U.S. Missiles will be deployed to protect the highly industrialized sector of northern Kyushu from air attacks.

The Missile/Space Week

Union Opposes Contract Action

The United Auto Workers local at the Michigan Army Missile plant, which Chrysler Corp. has maintained since 1952, has pulled out all stops in an effort to frustrate the award of the maintenance contract for this plant to Ling-Temco-Vought's Michigan Div. beginning in February.

The disputed contract was actually awarded on Nov. 15 and drew immediate fire from Chrysler Local 1245, claiming that the decision was made outside of established procedures and without regard to competitive bidding.

The Chrysler-based local strongly implies White House string-pulling on behalf of the Dallas-based LTV.

The union position paper says that Chrysler submitted the low bid on the Army's *Lance* missile contract but lost it to LTV. It also states that the *Lance* contract was awarded on the basis that the work would be performed at the Michigan Missile Plant but that most of the work is being performed in Canada by Hawker Siddeley Corp.

A top executive of LTV has strongly denied the union allegations, particularly the insinuation that the firm has benefited from White House intervention. He told MISSILES AND ROCKETS that only the lightweight launcher portion of the *Lance* system is being built by Hawker Siddeley and that at least 80 to 85% of the work on the *Lance* program will be done in Michigan.

Shots of the Week

Pioneer 6, first in a new series of interplanetary spacecraft, was successfully launched from Cape Kennedy Dec. 16. An improved *Thrust-Augmented Delta* placed the 140-lb. satellite into a solar orbit, coming within 75,680,000 mi. of the Sun. Aphelion is in the Earth's orbital path; orbital period is 311 days. NASA officials reported that all six spacecraft experiments were returning good data.

- The *Gemini 6* spacecraft, carrying astronauts Walter M. Schirra and Thomas Stafford, was launched Dec. 15 by a *Titan II* booster, achieved orbit with *Gemini 7* and splashed down in the Atlantic at 10:29:09 a.m. EST, Dec. 16. (See article on p. 14.)
- A Strategic Air Command missile crew fired a *Minuteman* ICBM from Vandenberg AFB, Calif., Dec. 14. The missile's re-entry over the Pacific was observed by *Gemini 7* astronauts Frank Borman and James Lovell.
- The Soviet Union launched the *Cosmos 99* scientific satellite Dec. 10. All instruments were functioning normally, Tass said.
- A secret Air Force satellite was launched Dec. 9 from Vandenberg AFB, Calif., aboard a *Thor-Agena* booster.
- The Air Force successfully fired two *Athena* missiles from the White Sands Missile Range Test Complex at Green River, Utah, Dec. 6 and 10. Both missiles impacted downrange.
- Brazil, in cooperation with NASA, successfully launched the first sounding rocket from its Natal, Brazil, range on Dec. 15. Other recent sounding rocket firings include: NASA launch of a 51-lb. payload from Wallops Island, Va., on Dec. 15, aboard a *Nike-Apache* booster; Air Force firing of a *Black Brant III* single-stage probe Dec. 8 from the Santa Rosa Island launch facility; Air Force firing of a *Nike-Javelin* rocket with a 178-lb. payload and an *Arcas* rocket carrying a weather balloon, both on Dec. 11 and both from Santa Rosa.

AOSO Program Scrapped

The space agency has stopped development of the *Advanced Orbiting Solar Observatory* project as an economy measure, but indications are that the program will be reinstated sometime in the future.

The satellite program, with a budget of $39 million through FY 1966, was under prime contract to Republic Aviation Corp., now a division of Fairchild Hiller Corp. At the time of cancellation, a prototype spacecraft was being developed. Some $24.9 million of the Fiscal '66 funds would be recoverable, NASA said.

AA Responsibilities Set

NASA has officially assigned management responsibilities for the *Apollo* Applications program to various areas in its manned spaceflight organization.

Overall management will be the responsibility of the *Saturn-Apollo* Applications program office at NASA Headquarters.

Marshall Space Flight Center will be responsible for development and procurement of launch vehicles, integration of experiments into the Lunar Excursion Module, *Saturn* instrument units and S-IVB stages.

Manned Spacecraft Center will be responsible for development of all standard and modified spacecraft (Command, Service and Lunar Excursion Modules), astronaut activities, flight operations and integration of experiments in the Command and Service Modules.

Seamans Named NASA Deputy

Dr. Robert C. Seamans, NASA associate administrator for the past five years, has been named to the post of deputy administrator held by the late Dr. Hugh L. Dryden.

Seamans is a Harvard graduate with M.S. and Ph.D. degrees from the Massachusetts Institute of Technology. He did research work and taught at MIT for 15 years before joining Radio Corp. of America as manager of its aerospace laboratory.

Lockheed Fires 156-in. Motor

Lockheed Propulsion Co. has fired the first flight prototype of its 156-in.-dia. solid-propellant rocket motor's stage one.

The nose-down firing took place Dec. 14 at the firm's Potrero, Calif., facility. It was termed "highly successful" by Col. Harold W. Robbins, director of large solid-rocket programs for the Air Force Space Systems Div.

The one-segment rocket developed about 3 million lbs. of thrust for one minute. The prototype, designated 156-5, achieved this thrust by use of 700,000 lbs. of propellant burning at twice the rate of those used in earlier 156-in. firings.

The propellant was selected from the polycarbutene family of polybutadiene formulations. The prototype stage was made up of a 150-ton, 22-ft.-long center segment and forward and aft segments of almost equal size, and was 75 ft. tall.

The static firing was first of three tests to demonstrate flight-weight prototypes that, according to SSD, could make up the first, second and third stages of a 156-in. multipurpose launch vehicle.

Soviets Seek Space Cooperation

A Radio Prague broadcast has reported that the Soviets have invited other Communist nations to participate in the Russian space pro-

RCA® Aerospace and Defense News

IDEAS AND CAPABILITIES REPORT FROM
RCA DEFENSE ELECTRONIC PRODUCTS

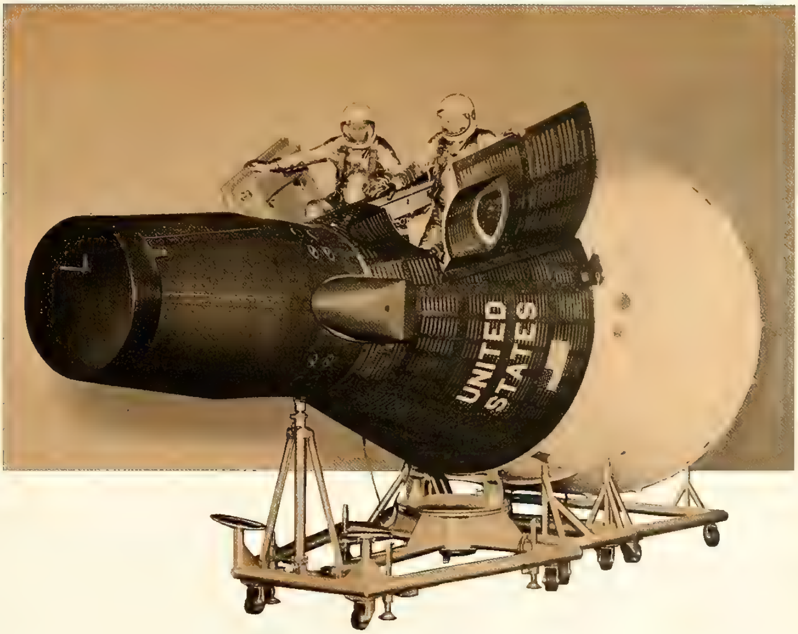
GEMINI SPACECRAFT FEATURES RCA SYSTEMS

RCA-built FPS16 and FPQ6 radars, as part of the NASA tracking network, deliver data to aid the astronauts and NASA mission control in the present phase of the U.S. Space Program.

In addition to its tracking radars, RCA also supplies the special man-rated aerospace tape recorder which stores information about spacecraft performance and condition.

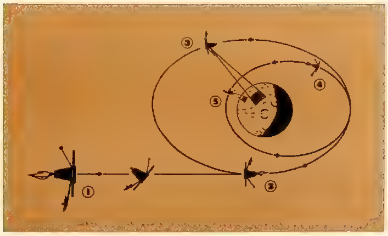
This information and other data, including astronauts' heartbeats, respiration, blood pressure, etc. will be transmitted to earth by an RCA-built telemetry transmitter.

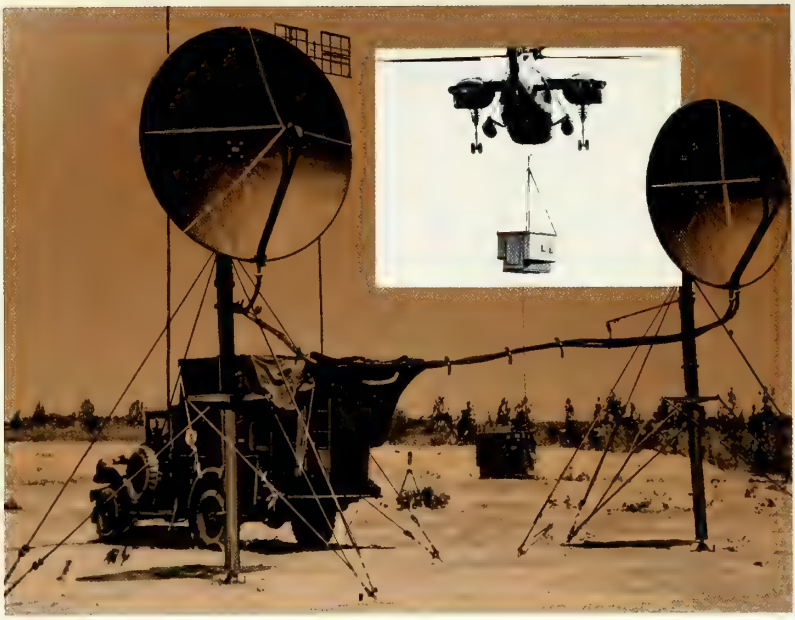
RCA has also supplied NASA with a Laser Transmitter which will be used on Gemini in a voice communications experiment. This experiment, if successful, will be the first transmission of voice to earth over a beam of light. Only 6 pounds, the Laser Transmitter is battery powered and operates at room temperature. The heart of this unusual transmitter is a semiconductor circuit featuring tiny gallium arsenide light-emitting diodes—the latter developed at the David Sarnoff Research Center.



LUNAR ORBITER TO PHOTOGRAPH MOON SURFACE, FOR LANDING SITE EVALUATION

Sketch outlines the mission profile of the Lunar Orbiter unmanned spacecraft. Separated from its booster, the 850-pound vehicle uses its tiny rocket to make a course correction (1) as it approaches the moon on its photographic mission. Later, the rocket engine fires again to decelerate the spacecraft into an elliptical orbit around the moon (2). It remains in this orbit long enough for earth command stations to make final course adjustments and takes a series of test pictures (3) which are relayed to earth. Leaving this orbit (4), the craft moves into a tighter elliptical orbit and approaches within about 29 miles of the moon for a series of sharp, detailed pictures (5) of possible landing sites for manned missions to follow. The Orbiter will remain in orbit for months, long after its film is exhausted, to record data on micro-meteoroids, radiation and the moon's gravitational field. The Lunar Orbiter spacecraft by Boeing for NASA. Power and communications sub-systems by RCA Astro Electronics Division, Princeton, New Jersey.





AN/TRC-97 KILOWATT-POWER TROPOSCATTER COMMUNICATIONS SYSTEM—CONTAINERIZED FOR HELICOPTER DROP

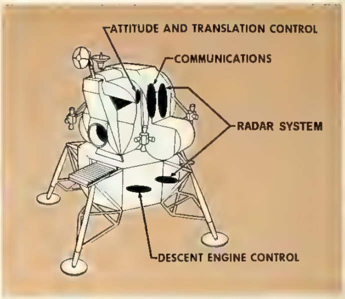
Marines call it "track 97." And it's aptly named, for this equipment puts operations wide communications in the most remote areas . . . fast. A complete system, operating in the 4.4 to 5.0 Gc military band, the RCA-built AN/TRC-97 transmits by troposcatter, diffraction or line of sight propagation, depending on path length and terrain. Maintenance is simplified—radio and multiplexing equipment are solid state, except for the exciter's TWT amplifier and transmitter klystron amplifier. System multiplexes 12 or 24 voice channels and 16 teletype channels and can also transmit computer data. Total package—all the electronics—fits a 72″ x 70.5″ x 66.5″ standard S-308 ¾ ton shelter in rack-mounted, operation-ready array. Antennas and power generator are carried in a standard military ¾ ton trailer which may be helidropped, if required. The entire system can be ready to talk within one hour from touchdown, due to a unique tuning scheme developed by RCA. This equipment is now being produced at the Camden, New Jersey facility of RCA's Communications Systems Division.

DIMATE AUTOMATES TEST OPERATIONS AT AN ARMY DEPOT

DIMATE—Depot Installed Automatic Test Equipment—cuts maintenance testing and response time, and frees skilled technicians for other assignments. Designed and built by RCA for the Army, DIMATE recently achieved full operational status at the Tobyhanna Signal Depot, Tobyhanna, Pa.

DIMATE provides power and input signals to equipments under test and measures their response. The DIMATE computer compares these responses to program data stored in its memory and prints out test results and simple maintenance instructions. DIMATE has proved ideal for checking readiness of equipment stored at, or processed through, the various military depots.

Although depot installed, the DIMATE racks and drawer-type assemblies are militarized and shelter mountable for field maintenance shop applications. It is produced by RCA Aerospace Systems Division, Burlington, Massachusetts.



LEM ELECTRONICS SYSTEMS BY RCA

NEW 200-MILE DME

Ground speed and minutes-to-go information, with accurate digital readout up to 200 miles, are available in today's RCA AVQ-75 Distance Measuring Equipment. The AVQ-75 master distance ground speed indicator will also drive flight director's DME readouts.

Complementing the AVQ-75 is RCA's commercially proved-in-use AVQ-20 weather radar system. The AVQ-20 is engineered by RCA especially for airline, business jet and turbo-prop aircraft. It enables the pilot to identify and evaluate both intensity and location of storm cells in the flight path. Both AVQ-20 and AVQ-75 are produced by the RCA Aviation Equipment Department, 11819 West Olympic Blvd., Los Angeles, California.

RCA Welcomes Inquiries

Welcome indeed at RCA are all inquiries about design and development of both systems and hardware. Further information on any phase of RCA skills and potentialities is easily available from Radio Corporation of America, Defense Electronic Products, Bldg. 2-6, Camden, New Jersey 08102.

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gram in the form of their own satellites or through instruments in Soviet spacecraft.

According to the radio report, an international Communist meeting took place in Moscow last month to begin planning for the program. Attendees were listed as being from Bulgaria, Czechoslovakia, Cuba, East Germany, Hungary, Mongolia, Poland and Rumania, as well as Soviet Russia.

Soviet news agency Tass also announced last week that the USSR will carry out tests of "a variant of a system of landing space vehicles" in the Pacific between Dec. 16 and June 1, 1966. Soviet space shots have ended in land landings to date.

Dr. Lovelace Dies in Crash

The space medical community was saddened at the death of Dr. William Randolph Lovelace, director of space medicine for NASA and a pioneer in aviation and space pilot safety, in a plane crash near Aspen, Colo., Dec. 12.

Although Dr. Lovelace officially joined NASA in 1964, he was chairman of a number of NASA medical committees, including the Medical Advisory Group that set up medical standards for the *Mercury* and succeeding flight programs.

He also was president of the Lovelace Foundation in Albuquerque, N.M., and a brigadier general in the Air Force Reserve. During his active service with the Air Force in the 1940's, he served as director of the Aeromedical Laboratories at Wright Patterson AFB, working on problems of the effects of flight on the human organism and life-support equipment.

Among Lovelace's recent achievements at NASA was the instigation of an agreement with the National Institutes of Health to improve the scientific quality of flight medical experiments conducted by NASA through the use of NIH's proven review system.

Metsat Requirements Outlined

Requirements for an operational weather satellite are that it be synchronous, stabilized, predictable and cheap, Dr. Wehner Suomi, chief scientist of the U.S. Weather Bureau, told a meeting of the AIAA at San Francisco.

Suomi also pointed out that present weather satellites are limited in providing cloud photographs. He stressed the importance of a means of measuring temperatures in the atmosphere at different altitudes as it varies over a 600-mi. grid.

How to cut the cost of upper atmosphere research by more than 1/3rd.

Skua!

Bristol Aerojet Skua rocket puts a 5.5 Kg (12.2 lb) payload to 100 Km (328,000 ft) altitude—at less than two-thirds the cost of any other rocket!

The exceptional economics of the Skua are obtained by the simplicity of the charge with its case-bonded, end-to-end burning solid propellant, and the use of a recoverable, re-usable booster.

Proven in performance and reliability, the Skua is 13 cm (5.15 in) diameter, and can be assembled and fired by a two-man team. A mobile launcher, of novel closed-breech design, is also available. This, used in combination with the recoverable booster, gives Skua a high launch velocity, enabling it to be fired in strong winds, whilst at the same time ensuring low acceleration.

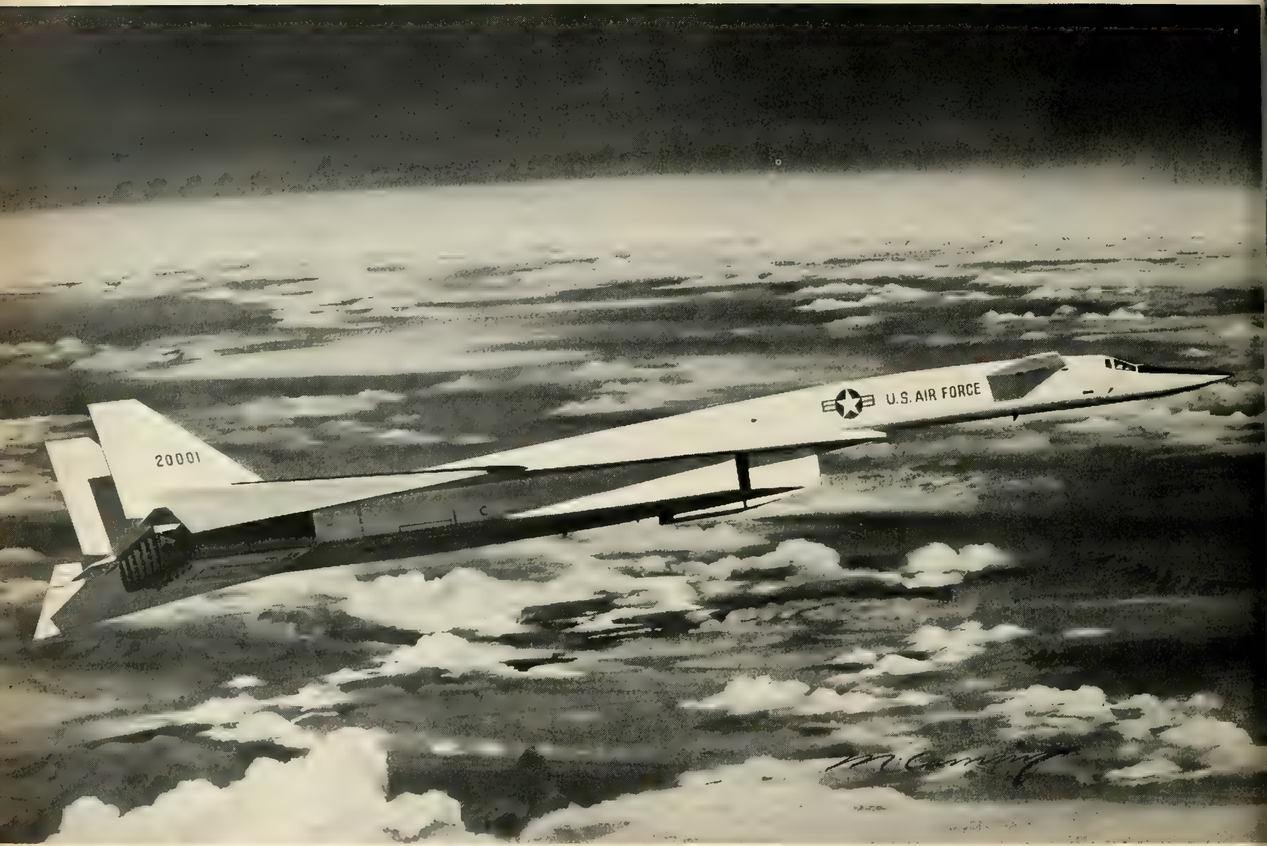
Instruments, therefore, do not need to be made to withstand high G values — the maximum acceleration never exceeding 60 G.

For further information, please write to: Bristol Aerojet Limited, Banwell, Weston-super-Mare, Somerset, England.

BRISTOL AEROJET

Circle No. 2 on Subscriber Service Card

The Mach 3 XB-70



The XB-70—250 tons of man and machine that moves faster than a one-ounce projectile fired from a high-powered rifle.

It has flown 2,000 mph—three times the speed of sound—at 70,000 feet.

Today, with more than a score of test flights in the record book, the XB-70 is an important national asset.

As a flying research laboratory, it is a vital contributor to America's future leadership in high-speed, high-altitude military and commercial flight.

The combination of range, speed, and payload being achieved with the XB-70 represents a major advance in the science of aircraft and systems design.

The XB-70 is the heaviest and largest aircraft designed to cruise at Mach 3 and above over long distances.

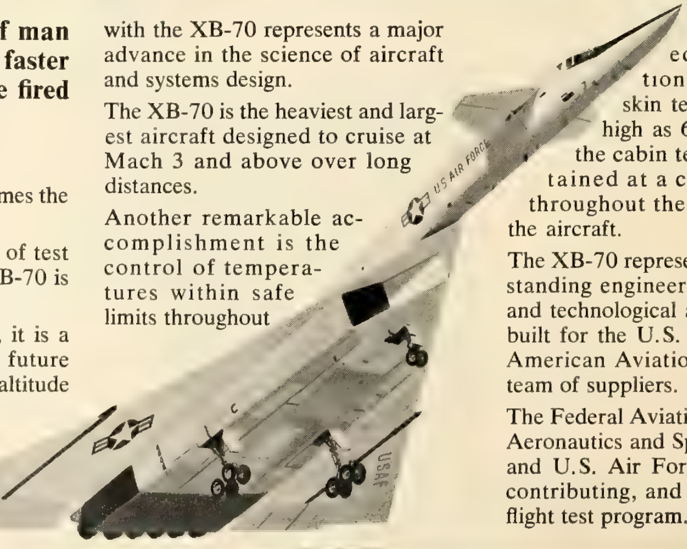
Another remarkable accomplishment is the control of temperatures within safe limits throughout the structure and equipment installations when the outside skin temperatures reach as high as 630°F. For example, the cabin temperature is maintained at a comfortable 80°F. throughout the operating range of the aircraft.

The XB-70 represents a number of outstanding engineering, manufacturing, and technological achievements. It was built for the U.S. Air Force by North American Aviation and a nationwide team of suppliers.

The Federal Aviation Agency, National Aeronautics and Space Administration, and U.S. Air Force are participating, contributing, and benefiting from the flight test program.

North American Aviation

Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Science Center, Space & Information Systems



Success Spells Change in Gemini Plans

Direct-ascent rendezvous exercise may now come much sooner; NASA still intends to fly all remaining missions; report on GT-7/6

SUCCESSFUL RENDEZVOUS of the *Gemini 6* and *7* spacecraft is expected to bring a revision in future mission requirements for the two-man spaceflight program.

One major change would call for a much earlier attempt to achieve direct-ascent rendezvous—the method which eventually will be used by Project *Apollo* astronauts when they leave the lunar surface.

Future flights probably will also see attempts to achieve rendezvous earlier than the fourth-orbit meeting during last week's flights—and more difficult inflight space maneuvers, including greater plane changes.

At the same time, program officials insisted that none of the remaining five flights would be dropped from the program. They said that in addition to the mission changes, the rest of the flights are needed for continued astronaut flight training.

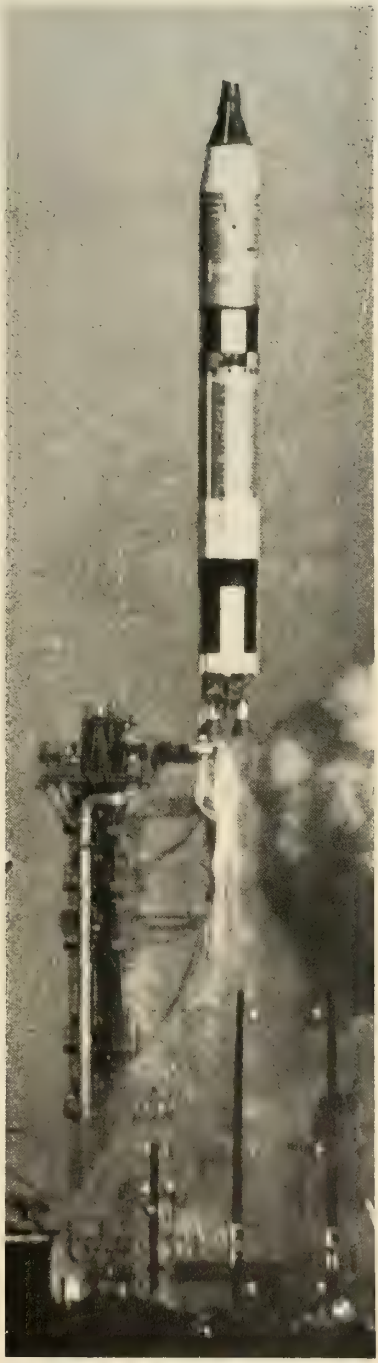
Final changes in the flight plans for the upcoming missions will not be made until project officials have a chance to de-brief *Gemini 6* astronauts Walter Schirra and Thomas Stafford and *Gemini 7* crewmen Frank Borman and James Lovell. Following successful rendezvous with *Gemini 7* on Dec. 15, *Gemini 6* successfully re-entered the atmosphere and impacted at 10:29 a.m. EST in the Atlantic Ocean 660 miles south of Bermuda.

The splashdown, only 12 mi. from the aircraft carrier USS Wasp, was the closest to a planned target area ever achieved in the *Gemini* series.

Even as *Gemini 6* hurtled into the atmosphere, the *Gemini 7* mission continued into its thirteenth day of flight, with splashdown planned for Dec. 18.

If they complete their planned 14-day mission, the *Gemini 7* crew will have orbited the Earth for 329 hours and 30 minutes—the longest flight in the history of the space age. Together with the 25-hr., 52-min. flight of *Gemini 6*, launched from Cape Kennedy on Dec. 15, it will give the U.S. a new total of 996 hours, 46 minutes of manned spaceflight.

Late on the 12th day of the *Gemini 7* flight, there was an indication that a problem was developing in one of the fuel cells. Flight Director Christopher Kraft said, however, that he did not believe it would shorten the mission. That and loss of two attitude thrusters were the only malfunctions of any significance encountered during the flight.


Perfect launch of Gemini 6 on Dec. 15.

False start—The *Gemini 6* mission was tarnished by two vexing problems during its first launch attempt on Dec. 12. The engines were ignited, but there was no liftoff because an electrical disconnect plug accidentally detached itself from the vehicle. Inspecting the launch vehicle, engineers later found that a plastic dust cover had been left in the oxidizer inlet to the gas generator. Thus, even if the plug had not disconnected, the malfunction detection system would have automatically shut down the engines about a second later than they actually did.

Space agency officials said that the *Gemini 6*/*Gemini 7* rendezvous technically occurred with the braking maneuver at 5 hrs., 50 min., 47 sec. into the flight. The two spacecraft broke into the daylight at about 175 degrees west by 25 degrees north, separated by a distance of about 1.3 n. mi. The rendezvous was made at a point roughly northwest of Guam over the Mariana Islands and within radio range of the tracking ship Coastal Sentry Quebec.

Gemini 6 pulled into the *Gemini 7* orbit some 120 ft. ahead or just slightly off the nominal. This apparently was the onboard computer-directed intercept point.

Kudos—After the rendezvous, space officials cited the excellence of the equipment, praising the on-board Westinghouse rendezvous radar equipment, the IBM computer, and the Honeywell inertial platform that combined to permit the rendezvous with a minimum use of thruster fuel. Also congratulated by Kraft was the Philco/IBM/Univac Mission Control Center complex. Every orbital problem given to the computer center personnel was solved, Kraft said.

The *Gemini-Titan 6* rendezvous attempt provided several U.S. firsts: 1) a dog-leg trajectory during launch, using the second-stage engine by shifting from the initial launch azimuth of 81.4 to 85.2 degrees; 2) two-vehicle co-orbital coplanar mission; 3) space-to-space voice communications; 4) space-to-space radar track and the ultimate rendezvous; and 5) nearly complete photocover by both vehicles of the rendezvous and measurement by *Gemini 7* of the *Gemini 6* thruster plumes. Thruster

Navy frogmen prepare to open hatch on Gemini 6, which splashed down just 12 mi. from USS Wasp.

problems on the *Gemini 7* spacecraft made it impossible to obtain infrared measurements and photo-cover of the *Gemini 6* re-entry and splashdown.

The only serious equipment problem occurring on *Gemini 6* was the early failure of the on-board RCA tape recorder (the same type of instrument that failed early on the *Gemini 7* flight).

GT-6 launch nominal—"Happiness is the successful launch," exclaimed Col. Richard C. Dineen, Air Force *Gemini* launch vehicle director, shortly after insertion of *GT-6* into orbit. That about summed up the feelings of all concerned.

The final countdown proceeded without problems to T minus three minutes. A planned 25-minute hold was then initiated to await the precise launch time of 08:37:26.4 a.m. EST. Ignition was at 08:37:23 and liftoff occurred 3.47 secs. later.

Although liftoff was obscured, the upper flight of *GT-6* was partially observed by the *GT-7* crew as it passed overhead during its eleventh day of flight.

Speed of *Gemini 6* at insertion was 17,535 miles per hour—8 mph below planned velocity. The relatively minor velocity changes effected later by the astronauts corrected both speed and orbital path in preparation for the hoped-for rendezvous in the fourth revolution northwest of Guam over the Mariana Islands in the Pacific Ocean. Launch azimuth was 28.97 degrees. Orbital period was 88 minutes 42 seconds.

Bermuda tracking station reported a nearly perfect trajectory, leading to an orbit of 140.4 n. mi. apogee, 87.2 n. mi. perigee—only 5.6 n. mi. below the planned apogee. Thus a 14-fps velocity correction (at plus 01:34:02) was required in height and a 31.3-fps velocity correction several hours later to effect a coplanar orbit with *GT-7*. To catch up (phase adjustment), a 60.8-fps forward change in velocity was required (T plus 02:18:00).

Nearing rendezvous—Other orbital corrections made by *Gemini 6* in preparation for rendezvous occurred as follows: 1) at T plus 02:42:07, a 31.7-fps posigrade velocity was employed to effect a plane change; 2) at T plus 03:03:19 a very slight height correction with a velocity increase of .08 fps, was made (referred to by capsule communicator Elliot See as a tweaking maneuver); 3) At T plus 03:47:37 circularization of *GT-6* orbit was performed with a 42.5-fps posigrade maneuver, changing the orbit ephemeris to approximately 148 by 144 n. mi.—very close to the desired 15-n. mi. path below the *GT-7* orbit of 163 by 159 n. mi.

First rendezvous radar lock-on by *Gemini 6* to its sister spacecraft was reported at about 12:05 p.m. EST, at a slant range between 235 and 240 n. mi.

Voice communication between the craft was established shortly afterward, when closure was below 200 n. mi.

First visual sighting of *Gemini 7's* flashing lights by *Gemini 6* was made at about 12:40 p.m. EST. Slant range was then between 35 and 40 n. mi.

Terminal Phase Initiation (TPI) was employed to bring *Gemini 6* up to the same orbital path as *Gemini 7* at an elapsed time of 05:18:39 with a 33.7-fps velocity correction. TPI occurred initially over the Philippine Islands. Closure was then under 25 n. mi. By the completion of TPI some 505 lbs. of thruster fuel remained.

Terminal Phase Finalization (TPF), a braking or retrograde maneuver of 42.5-fps change, was started at 05:48:40, bringing the two spacecraft finally to within 120 ft. slant range of each other. Station keeping began at 05:50:00. Fully 50% of the orbital-attitude maneuvering system (OAMS) fuel remained at this point.

THIS REPORT on Gemini 7/6 orbit and rendezvous was prepared by NASA Editor Hal Taylor at Cape Kennedy and Senior Editor Charles D. LaFond and Contributing Editor Jinx Mercer, both of whom covered the story at Gemini Mission Control Center, Houston.

In formation—Slowly, Command Pilot Schirra closed to 20 ft. in distance—then to a position 10 ft. to the side of *Gemini 7* and about 15 ft. above. *Gemini 6* then moved closer into line with *Gemini 7*—nose to nose, with the distance varying from 6 to 10 ft. Both vehicles were believed to be in a heads-down position.

NASA estimated that 325 lbs. of OAMS fuel was required to complete the rendezvous from TPI down to the 10-ft. closure. They said this was far below the amount allotted for this portion of the rendezvous.

Discussing the combined use of the radar platform and the computer for rendezvous, Elliot See told a press briefing that all systems were completely good all the way, and the astronauts were able to use closed-loop guidance throughout the exercise. He said the astronauts were plotting backup rendezvous calculations, in case of an equipment failure, but were able to initiate and complete the rendezvous on closed-loop guidance.

See also praised astronaut Stafford for his ability, in spite of all of his rendezvous tasks at the time, to read some 20 different positions to ground. He said the quality of the radar tracking, which was compared repeatedly with ground track during the maneuvers, was "amazing."

To complete their mission requirements, *Gemini 6* performed in-plane and out-of-plane maneuvers about the *Gemini 7* spacecraft. Distances varied from 20 to 100 ft. during these maneuvers. Later, *Gemini 7* performed the same tasks while *Gemini 6* maintained position.

Alternate Target Vehicle To Be Built for Gemini 8

THE SPACE AGENCY has announced that it will develop an alternate docking target vehicle for possible use in the *Gemini 8* mission.

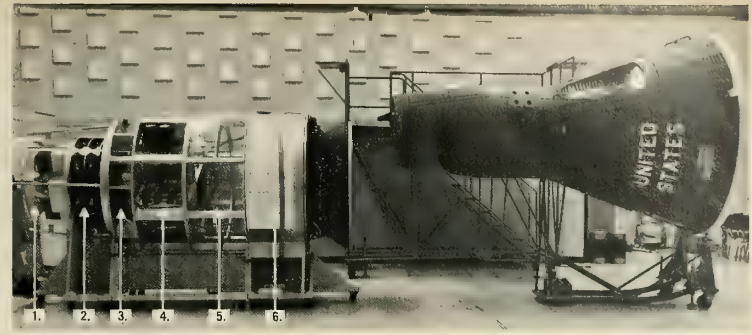
The agency said the alternate target docking adapter (ATDA)—which will be developed by McDonnell Aircraft Corp.—will be used only if the program's Lockheed *Agena* target vehicle is not ready for a first-quarter 1966 launch (M/R, Dec. 13, p. 13).

Space agency officials said a final decision as to which target vehicle will be used will be made in late February or March.

The *Agena* is expected to be delivered to the Arnold Engineering Development Center late this month. A series of wind-tunnel tests will begin in mid-February. If the tests are completed and no further problems crop up, the *Agena* will be used for *Gemini 8*.

The *Agena*—following its Oct. 25 explosion—has been modified so that the Bell Aerosystems engines have a fuel-control system similar to that of the standard Air Force *Agena* vehicle. This consists of an oxidizer manifold pressure switch, an oxidizer discharge pressure switch and positive control relay.

Bell announced last week that the new engines had successfully completed their acceptance testing.



Model of alternate rendezvous and docking target vehicle shows: 1) battery section; 2) re-entry control section; 3) RCS tankage; 4) orbital attitude and maneuvering electronics digital command system and DC-DC converter; 5) equipment section; and 6) standard target docking adapter, including rendezvous transponder.

Single-copy vehicle—The ATDA will be made up of existing qualified *Gemini* hardware and launched by a standard *Atlas* launch vehicle. Only one will be built. Equipment to be used in the ATDA includes *Agena* nose shroud, target docking adapter, *Gemini* re-entry control section (RCS), *Gemini* orbital attitude and maneuvering electronics, *Gemini* digital command system, *Gemini* electrical system components and *Atlas-Agena* adapter.

The only new equipment to be developed is shell structure to house the components. The ATDA will weigh about 2,400 lbs. at launch and about 1,700 lbs. in orbit.

It would be launched directly into a 185-mi. circular orbit. It will be equipped with an automatic rate-stabilization system. Thrusters in the RCS will be used to control attitude.

General Dynamics' Convair Div. and the Air Force Space Systems Div. will serve as integration contractors. Guidance and reference trajectories will be furnished by TRW, Inc. Total costs are expected to be less than $1 million.

Agena engine testing is continuing at Bell Aerosystems Co. and facilities at Arnold are being readied rapidly for complete engine revalidation under simulated high-altitude conditions.

It is expected that the *Agena* will be delivered shortly.

In performing the D4 Air Force experiment, *Gemini 7* obtained infrared measurements of the *Gemini 6* thruster plumes from relatively close distance.

At 9 hrs., 42 mins. elapsed time, the spacecraft separated, maintaining a distance of 20-30 miles to permit *Gemini 6* to perform an *Apollo* sextant experiment. This position was maintained throughout the night.

Docking looks easy—The astronauts all agreed that rendezvous in space was considerably easier than maneuvers in the ground simulator—and predicted that there will be no difficulty in performing the docking maneuver.

During their close approach, astronauts in both vehicles were able to observe a 10-15-ft.-long wire trailing out behind each adapter ring. No real identification of this wire has been made, although Chris Kraft stated it could be an electrical wire severed by the guillotine charge from the second-stage booster but not from the spacecraft's ring. The only other explanation, said Kraft, is that it is the wire remaining from the explosive charge around the entire ring of the spacecraft adapter.

Circularizing—The plan to circularize the *Gemini 7* orbit and begin a procession of launch opportunities for *Gemini 6* was put into operation on the fifth day.

Command pilot Frank Borman powered up the platform and computer in the seventh revolution and at 119 hrs., 11 min. "burned" aft rockets in posigrade for an incremental velocity of 61.2 fps to raise perigee from 127 to 162 n. mi. One-half orbit later, he lowered apogee from 169 to 162 n. mi. by performing a 15.5-fps maneuver in retrograde.

Ground tracking data indicated *Gemini 7* was circling Earth in an "exactly" circular orbit predicted to decay to 161 n. mi. by the time *Gemini 6* arrived on the scene.

Pilot James A. Lovell reported feeling comfortable despite traveling in his underwear. He donned the orbital flight suit—a two-piece, pajama garment provided for warmth if needed, but reverted to his original wear a short time later.

Capsule Communicator See relayed ground recommendations that the men switch their suit configuration. The objective was to get comparative data from Lovell on the suited versus unsuited modes before approving a "shirt-sleeves" environment for both men later in the mission.

The D-5 star occultation photometer, still inoperative, was run through another in-flight test to determine if radio frequency interference had "saturated" the sensitive equipment. The instructions specified turning off all transmitters and beacons, noting the color of the photometer reticle, and observing any signs of change as the equipment was brought back on line. (The equipment was set aside finally in the belief that it was non-repairable.)

The first attempt to communicate with the ground via a beam of light ended in failure when neither Borman nor Lovell could sight the flashing beacon on the Hawaiian island of Kauai.

A minor problem emerged when the crew began complaining of "stuffiness" and a drying out of their nasal passages. ■

Titan III Shot To Set Stage For Defense Comsat Project

by Michael Getler

LAUNCHING of the third in the series of *Titan III-C* research and development flights this week at Cape Kennedy will provide a dress rehearsal for orbiting of the initial round of defense communications satellites aboard the Air Force booster early next year.

All was in readiness late last week to launch the *Titan III-C* from Pad 41 at the new Air Force Integrate-Transfer-Launch (ITL) complex Dec. 21.

Both the ground and flight sequence for the upcoming flight involve milestones in the *Titan III-C* program:

—First flight in which the ITL concept has been fully implemented;

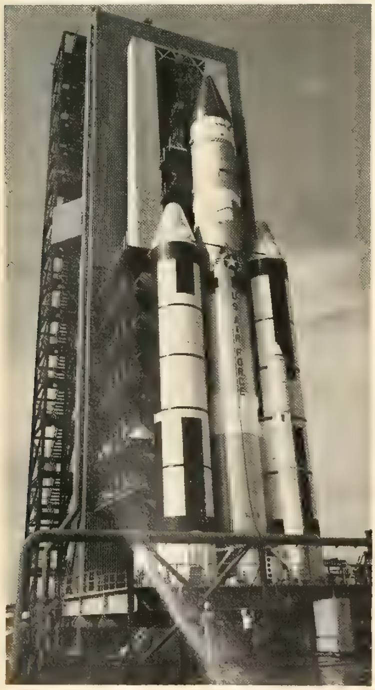
—First use of Pad 41 at the ITL complex;

—Application of some new pre-launch procedures and vehicle modifications;

—First mission for the Air Force booster in which a payload will be placed in a near-synchronous-altitude orbit;

—Test of a new in-flight roll sequence aimed at maintaining better thermal equilibrium.

Air Force Titan III-C launch vehicle poised for scheduled Dec. 21 flight.



Mission plan—The current flight plan for the mission calls for the vehicle to first lift its 931-lb. payload, which includes four satellites, into a circularized, 90-n.-mi. parking orbit inclined 29 degrees to the equator. A second burn of the vehicle's third stage Transtage engine will put the stage and the payload into a 4-hr., 45-min. coast maneuver to achieve an elliptical orbit ranging from 90 n. mi. to 18,200 n. mi., and will change the orbital plane to about 26 degrees.

During this coast phase, the *Titan III-C* will be put through five separate roll maneuvers using the attitude control system motors. This procedure, which Air Force officers call "toasting," is designed to alter the orientation of the vehicle with respect to solar heating to maintain heat-transfer equilibrium.

Once in the elliptical orbit, the Transtage will be fired for a third and last time to circularize the orbit at 18,200 n. mi. and change the orbital plane to a position above the equator.

The flight plan, certainly the most ambitious to date for the *Titan*, exercises the booster to what Air Force officers feel will be close to its ultimate capability and ought to be an excellent indicator of its ability to complete some of the more complex missions assigned to it.

Later flights—Of immediate interest is the series of three *Titan III-C* launchings that will follow this one. Each of these three flights will carry eight satellites of the Initial Defense Communications Satellite Project.

The IDCSP calls for virtually the same flight plan, and the combined payload weight of the eight 100-lb. satellites plus dispenser and support structures closely parallels the weight associated with tomorrow's planned launching.

Total mission time for the upcoming *Titan* flight is roughly 6.5 hrs. The four satellites, including two more in the series of Lincoln Laboratory experimental communications satellites (*LES-3* and *4*), an Air Force OAR orbital vehicle (*OV-2-3*), and another *OSCAR* Amateur Radio Relay League satellite, will be deployed roughly 30 seconds apart, according to the Air Force.

The satellites will be ejected so that they drift eastward above the equator at a rate of about 30 degrees of longitude per day. Before deployment, the vehicle will be turned toward the west so that the solar energy system and experiment portions of the *OV-2-3* satellite will be properly oriented to the Sun.

Ground facilities—Both of the prior *Titan III-C* flights have been made from Pad 40 at the Air Force launch complex.

For the first flight June 18, the buildup of the *Titan III* core, payload and solid-motor strap-ons, and the associated electrical and mechanical mating tests, were made on the launch pad.

For the second flight Oct. 15, the Air Force did use a large portion of the ITL procedures and facilities, but still performed the electrical mating and checkout on the launch pad.

During pre-flight procedures for the second launching, the Air Force made full use of the vertical integration building at the complex for staging and mechanically mating the core vehicle. The solid motor assembly building was used for the first time to assemble and test mechanical mating of the five-segment solid motors. The assembled vehicle was moved by the rail transporter network to the launch pad for the Oct. 15 flight.

For the Dec. 21 flight, use of Pad 41 for the first time and the launch of a vehicle that has been fully assembled and checked out before movement to the pad will signal operational status for the ITL complex. Air Force officers say they are pleased with preliminary analysis of the ITL operations.

Revised pre-launch procedures include making complete vehicle tankage pressure checks much closer to the time of launch rather than earlier in the checkout sequence, and also installation of heater blankets on the Transtage engine propellant valves and vent lines to head off any possible line-freezing problems during the long coast phase.

Of the eight remaining *Titan III-C* R&D vehicles, three are scheduled to be flown in the spring and summer of 1966, two in the fall of 1966, and three in 1967.

The next three flights will all launch IDSCP satellites. The two flights during the fall of 1966 will involve an additional pair of *Nuclear Detection Satellites* and probably *Manned Orbiting Laboratory*-associated components.

The final three flights, which may begin in late 1966 and carry over into 1967, will include a replenishment launch of communication satellites (including a comsat gravity gradient experiment), a back-up flight for the *NDS*, and finally a second *OV-2* solar activities satellite and another Lincoln Laboratory satellite. This last flight will place the *OV-2* satellite in a truly synchronous equatorial orbit. ■

TRW Systems Wins Comsat Nod

Firm's proposal for advanced global communications satellite system chosen over Hughes, RCA entries; negotiations begin

NEGOTIATIONS are under way between Communications Satellite Corp. and TRW Systems Group for a contract to develop and manufacture an advanced satellite for the global communications satellite system.

Initial phase of the contract—which calls for delivery of six to nine satellites—is expected to cost $30 to $40 million. The award includes options for up to 24 satellites for use in the global system, expected to be operational by 1968. Negotiations will probably be completed by late March, with delivery of the first six satellites 24 months later.

The negotiations were approved earlier this month by the International Telecommunications Satellite Consortium, comprising 47 countries. Comsat, manager for the international group, issued a request for proposals for the advanced satellite last August. Hughes Aircraft Co. and Radio Corp. of America also submitted bids.

In conjunction with the program, TRW Systems has issued 10 requests for proposals on subsystems. Due this week, these include communications, telemetry and command subsystems; despun antenna subsystems; solar arrays; equipment converters; power control units; control electronics; electrical integration assembly; position and orientation subsystem; structural subsystem; and spacecraft integration and test equipment.

Satellite details—In line with Comsat's stated requirements, the 234-lb. satellite would be spin-stabilized, with the spin axis normal to the orbital plane, and would provide 1,200 high-quality, two-way voice channels. Required operational life is five years minimum. The TRW Systems satellites will be cylindrical, 56 in. in diameter and 37 in. high. They would be launched in groups of four by an *Atlas-Agena* booster.

In its proposal, TRW Systems provided for guaranteed delivery of six satellites within 24 months of contract award, followed by delivery of three lots of three satellites 30, 37 and 42 months after contract award, if required. Dr. Morris Feigen will manage the program at TRW Systems.

Selection of a system, either synchronous or medium-altitude phased array, is expected to be made by Comsat six months after contract award. Since the satellite orbit has not been selected, current designs are intended for use in different orbits with only minor modifications. Orbits under consideration, in terms of period and inclination, are: 24 hrs., 0 degrees (synchronous); 12 hrs., 0 degrees; 12 hrs., 30 degrees; 8 hrs., 0 degrees, 8 hrs., 30 degrees; and 6 hrs., 0 degrees.

There is speculation that a synchronous orbit is preferred because each ground station under construction by Comsat is equipped with only one 85-ft. antenna. A medium-altitude system calls for two antennas at each site.

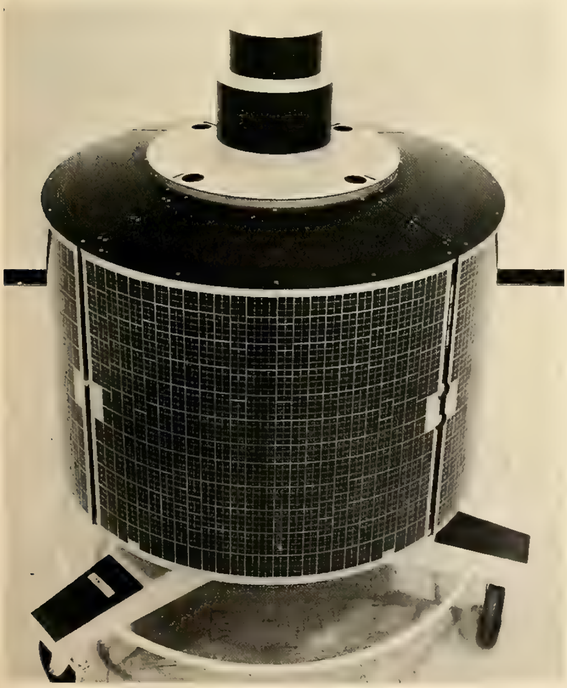
The 40-ft. transportable antennas being supplied to Comsat by Page Communications Engineers for use in the *Apollo* communications satellite system could serve as the second antenna but at the cost of additional complexity.

Political obstacles—Main problem of orbit selection seems to be not so much technical as political, involving the specialized communications requirements of each nation involved. Japan and Norway are said to prefer an inclined orbit that would give good coverage at northern latitudes. France is said to favor a 12-hr. system that will provide a good link between Europe and Africa. Britain is reportedly vacillating between an 8-hr. and a 12-hr. orbit.

These disparate interests will have to be reconciled in some compromise system and unofficial feeling identifies the synchronous orbit as the one capable of giving the best general global coverage.

The satellite proposal by TRW Systems is capable of operating in phased relationship at medium altitudes (8,000 to 16,000 mi.) or in synchronous orbit (23,000 mi.). For the most part, the satellites lean heavily on the established state of the art, with the exception of use of electronically de-spun antennas. However, this form of antenna is likely to be proven out in a classified Air Force program in 1966 and in the NASA *Applications Technology Satellite* in 1967.

For each orbital altitude, the proposed satellites will require a different apogee motor. Different thicknesses of glass protection for solar cells and different areas of solar cell will also be required. ■



Model of TRW Systems Group's winning entry in the competition for a satellite for the advanced global comsat system. The 234-lb. satellite will be spin-stabilized and is to provide 1,200 two-way voice channels.

NASA LIST OF FY 1965 TOP 100 PRIME CONTRACTORS

	CONTRACTOR	RANK IN FISCAL YEAR 1964	NET VALUE OF AWARDS	
			THOUSANDS OF DOLLARS	PERCENT OF TOTAL AWARDS TO BUSINESS
	TOTAL AWARDS TO BUSINESS		$4,141,434	100.00
1	North American Aviation, Inc.	1	1,099,448	26.55
2	Boeing Company	4	305,988	7.39
3	Grumman Aircraft Engineering Corp.	5	267,226	6.45
4	Douglas Aircraft Co., Inc.	3	251,668	6.08
5	General Electric Co.	7	181,472	4.38
6	McDonnell Aircraft Corp.	2	166,670	4.02
7	International Business Machines Corp.	10	128,312	3.10
8	Aerojet-General Corp.	8	123,186	2.97
9	General Dynamics Corp.	6	111,148	2.68
10	Radio Corp. of America	11	106,552	2.57
11	Chrysler Corp.	9	85,986	2.08
12	General Motors Corp.	13	72,531	1.75
13	Bendix Corp.	12	66,100	1.60
14	TRW Systems	16	50,533	1.22
15	United Aircraft Corp.	17	43,330	1.05
16	Sperry Rand Corp.	28	39,401	.95
17	Lockheed Aircraft Corp.	15	35,796	.86
18	Collins Radio Co.	51	31,532	.76
19	Brown Engineering Co., Inc.	14	30,850	.74
20	Philco Corp.	18	30,029	.73
21	Hayes International Corp.	22	28,496	.69
22	Honeywell, Inc.	40	27,068	.65
23	Hughes Aircraft Co.	25	26,457	.64
24	Catalytic Construction Co.	44	25,296	.61
25	Trans World Airlines, Inc.	—	20,862	.50
26	Union Carbide Corp.	21	19,954	.48
27	LTV Aerospace Corp.	20	15,118	.37
28	Fairchild Hiller Corp.	31	14,720	.36
29	Mason-Rust	27	13,097	.32
30	Westinghouse Electric Corp.	45	12,647	.31
31	Radiation, Inc.	30	12,056	.29
32	Control Data Corp.	24	11,808	.29
33	Bellcomm, Inc.	37	9,804	.24
34	Pacific Crane & Rigging	—	9,280	.22
35	Martin Marietta Corp.	38	8,389	.20
36	Lear Siegler, Inc.	73	8,260	.20
37	Air Products & Chemicals, Inc.	33	8,135	.20
38	Republic Aviation Corp.	35	7,537	.18
39	Thiokol Chemical Corp.	69	7,441	.18
40	Northrop Corp.	36	7,297	.18
41	Garrett Corp.	57	7,179	.17
42	Scientific Data Systems	53	6,800	.16
43	American Machine & Foundry Co.	66	6,614	.16
44	Dynatronics, Inc.	—	6,436	.16
45	Spaco, Inc.	46	6,308	.15
46	Avco Corp.	52	6,299	.15
47	Electronic Associates, Inc.	63	6,025	.15
48	Motorola, Inc.	76	5,830	.14
49	Sanders Associates, Inc.	—	5,830	.14
50	Federal-Mogul-Bower Bearings, Inc.	32	5,603	.14
	TOTAL AWARDS TO BUSINESS		$4,141,434	100.00
51	Documentation, Inc.	39	$ 5,240	.13
52	Blount/Chicago Bridge	—	5,178	.13
53	Ball Bros. Research Corp.	43	5,036	.12
54	Keltec Industries	—	4,749	.11
55	Ampex Corp.	48	4,747	.11
56	Norair Engineering Corp.	—	4,736	.11
57	Electro-Mechanical Research, Inc.	47	4,615	.11
58	Vitro Corp. of America	72	4,435	.11
59	Dynamic Corp. of America	—	4,358	.11
60	Minnesota Mining & Mfg. Co.	—	4,257	.10
61	Graham Engineering Co.	—	4,063	.10
62	Brown/Northrop	—	4,060	.10
63	Beckman Instruments, Inc.	77	3,997	.10
64	Computer Control Co.	—	3,908	.09
65	Wolf Research & Develop. Corp.	—	3,882	.09
66	David Clark Co., Inc.	—	3,839	.09
67	Taag Designs, Inc.	—	3,790	.09
68	Zia Company	91	3,779	.09
69	Allis Chalmers Manufacturing Co.	—	3,701	.09
70	Pennsalt Chemical Corp.	—	3,559	.09
71	Consolidated Systems Corp.	81	3,555	.09
72	Calumet & Hecla, Inc.	—	3,418	.08
73	Aero Spacelines, Inc.	—	3,387	.08
74	MSI Corp.	—	3,386	.08
75	Bell Aerospace Corp.	49	3,328	.08
76	Space-General Corp.	64	3,293	.08
77	Hathaway E. A. & Co.	—	3,216	.08
78	Systems Engineering Labs, Inc.	89	3,019	.07
79	Electronic Communications, Inc.	—	2,952	.07
80	Consolidated Electrodynamics Corp.	58	2,938	.07
81	Kiewit/Leavell	—	2,820	.07
82	Electro Optical Systems, Inc.	84	2,808	.07
83	Sylvania Electric Products, Inc.	—	2,652	.06
84	Washington Technological Assn., Inc.	—	2,615	.06
85	Wise Contracting Co.	—	2,561	.06
86	Sun Shipbuilding & Dry Dock Co.	—	2,554	.06
87	Litton Industries, Inc.	—	2,449	.06
88	Virginia Electric Power Co.	—	2,421	.06
89	Western Union Telegraph Co.	—	2,397	.06
90	Universal Marion Corp.	—	2,341	.06
91	Swenson Carl N. Co.	—	2,324	.06
92	Whittaker Corporation	83	2,297	.06
93	Consultants & Designers, Inc.	—	2,207	.05
94	Raytheon Co.	19	2,200	.05
95	Canoga Electronics Corp.	95	2,172	.05
96	Int'l Telephone & Telegraph Corp.	71	2,153	.05
97	Dow Chemical Co.	—	2,070	.05
98	Melpar, Inc.	—	2,069	.05
99	Dortech Corp.	—	2,064	.05
100	Management Services, Inc.	74	2,061	.05
	Other		391,374	9.45

Technical Countdown

ELECTRONICS •

Software for 'Everyman' Computer Possible

Twenty programmers working for five years under a $10-million contract could produce the software needed for a computer system as easy to use as a slide rule. T. B. Steel, Jr., of Systems Development Corp., offered this answer at the Fall Joint Computer Conference to Rex Rice, of Fairchild Semiconductor, who suggested that advances in microelectronics would cut the price of a central-processor equivalent of an IBM 7094 to $1,200 by 1970. Total cost of a desk-size computer using this processor would be about $23,450, said Rice, provided it was sold in quantity. This would be possible only if engineers could use the machine easily and naturally, eliminating the present programming barrier. This, said Steel, calls for programming effort with a cost "that by today's standards is enormous." He estimated that about 500,000 instructions would have to be programmed, but said the total effort that would go into such a programming project would be clearly less than that going into the production of software for new commercial computer lines.

High-Density Core Memory Developed

An experimental 375-nanosec. computer memory using ferrite cores with 0.0075-in. internal and 0.012-in. external diameter has been constructed at IBM Systems Development Div. The experimental unit achieved a density of 4,000 bits of information per square inch. Its cycle time of 375 nanosec. is considerably shorter than the 750 nanosec. of the fastest memory in the IBM system 360. In a paper delivered at the Fall Joint Computer Conference, IBM engineers G. E. Werner and R. M. Whalen proposed a redesigned version using solid-logic technology modules to cut access time to 135 nanosec. and full cycle time to 250 nanosec. The authors also reported a potential 110-nanosec. cycle time based on the results of bench tests.

READI To Improve Propulsion Safety

To protect flight crews from catastrophic failure due to trouble in spacecraft rocket-engine systems, a performance monitor is being developed for NASA by Sperry Rand Corp. Called READI (Rocket Engine Analyzer and Decision Instrumentation), the on-board system will provide data processing to detect imminent trouble and provide remedial action against an abnormal engine condition within milleseconds of occurrence. Counteraction may vary from engine shutdown to the opening of an electrical circuit, depending on the kind of problem.

25-Nanosecond Memory Under Development

Feasibility of cycle times in the 25-nanosec. range has been shown in tests on a cross-section model of a tunnel-diode memory being developed by IBM. The device, intended to be a scratch-pad memory, has a capacity of 64 words of 48 bits. Memory units are contained on eight multi-layer cards, each 5 x 18 in. Each storage cell consists of one tunnel diode, a printed resistor, and an etched-copper transformer pattern.

MATERIALS

Aerojet To Supply Lab Service to WSO

A renewable one-year contract issued by LTV Aerospace Corp. to Aerojet-General's Von Karman Center calls for laboratory support services at NASA's White Sands Operations (WSO) in New Mexico. Aerojet will operate a materials lab for chemical testing, contamination control and metallurgy as well as still and motion-picture film facilities. LTV is under contract to NASA to supply all lab support services at the site.

Dornier Project 621 Successful

Unpowered gliding models of a recoverable sounding rocket have been successfully tested at the Italian Test Range on Sardinia. The concept is being developed by a team of German firms headed by Dornier Systems GmbH. During the tests, several 17-ft.-long full-scale models of the sounding rocket were dropped from helicopters at altitudes between 3,000 and 10,000 ft. A plastic-coated-fabric paraglider arrangement grounded the rockets only 300 ft. from a predetermined landing point. Recovery control was easily maintained by the ground operator within the 3-mi.-dia. circular recovery pattern. A complete ground-launched system could be operational by 1968. The sounding rocket could take instruments to altitudes of more than 50 miles and return intact to the launching point. Such a recoverable rocket system could be used to collect gases, meteorites and other data samples not suitable for telemetering.

Apollo Pallet Design Study Contract Let

A team consisting of Northrop Space Labs, Radiation, Inc., and Ball Brothers will perform a four-month design study on an experimental pallet to fly aboard *Apollo* missions. The team, one of four industry groups to be selected by NASA, will provide detailed specifications and produce a mockup of the pallet—designed to be placed in the Service Module. The other teams are headed by Lockheed Missiles & Space Co., McDonnell Aircraft and Martin-Denver. Each group will operate under a fixed-price contract totalling $375,000. The pallet will house scientific, technological and engineering experiments to be carried on *Apollo* missions lasting up to 14 days, beginning in 1968.

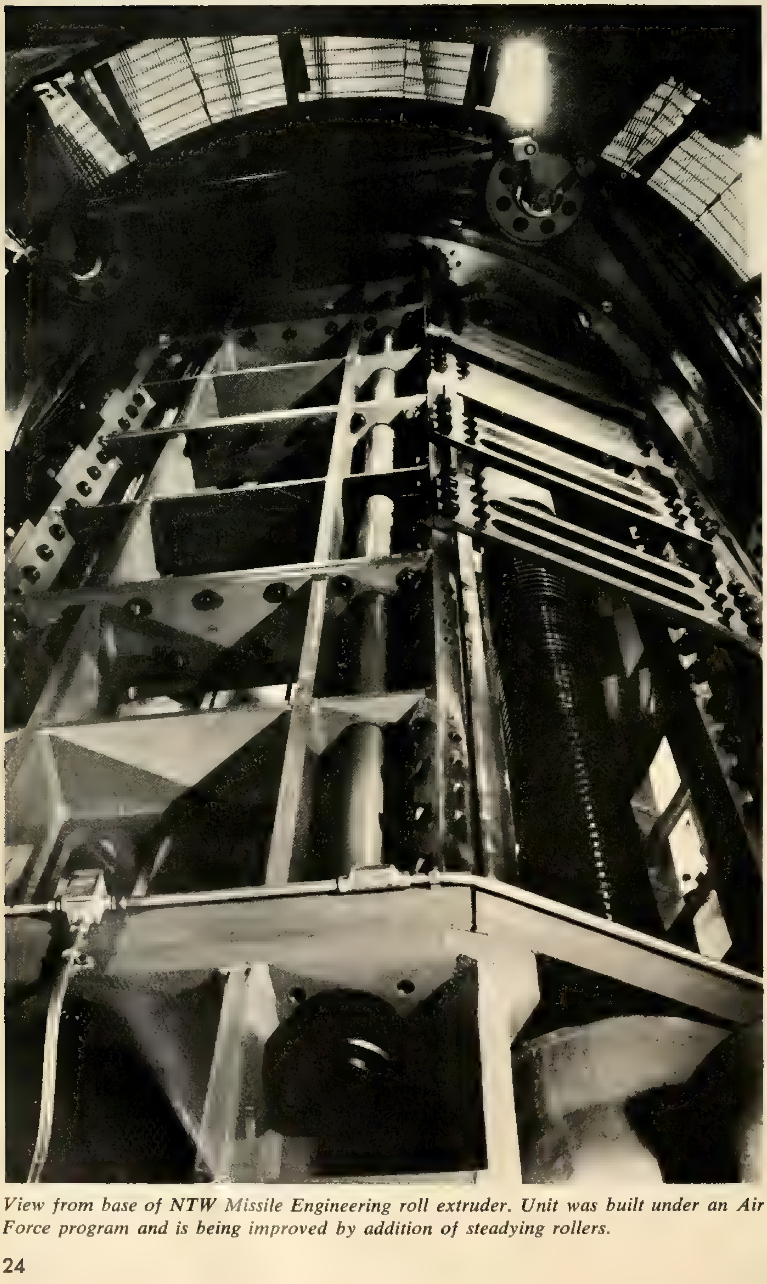
SPACE MEDICINE

Cosmonaut Sickness Reported

The Soviet news agency Tass has reported for the first time that two members of the *Voskhod 1* spacecraft crew were nauseated and disoriented during their mission in October, 1964. The two were Konstantin P. Feoktistov, a scientist, and the physician, Boris B. Yegorov. The third man—a highly trained fighter pilot, Col. Vladimir Komarov—reported no symptoms. The two affected said they imagined themselves to be in strange positions, both with and without their eyes closed. Soviet space scientists concluded that Komarov's training spared him these effects. U.S. space scientists share this theory.

Roll Extrusion Method Chosen For UTC 120-in. Motor Case

by John F. Judge



View from base of NTW Missile Engineering roll extruder. Unit was built under an Air Force program and is being improved by addition of steadying rollers.

A SINGLE 120-in.-dia. motor case segment will be fabricated through the roll extrusion method in a United Technology Center development program under a $263,830 contract from the Air Force Materials Laboratory.

The development case section will be 129 in. long and made from Republic Steel Corp.'s HP 9-4-25 steel plate. The program will conclude in December, 1966, with a hydrostatic test.

Plate will be provided to Westinghouse Electric Corp.'s Rocket Motor Case Dept., Lester, Pa., where it will be pre-formed in the heat-treated condition by rolling and welding.

The machined pre-form will then be shipped to NTW Missile Engineering, Vernon, Calif., for the roll extrusion process (M/R, March 15, p. 22). After extrusion, the case will be returned to Westinghouse for final machining and fabrication of the clevis joint. The unit will then be hydrotested.

The entire program is being managed by United Technology to their specifications. Development is aimed at laying groundwork for an advance in the state of the art including both material and structural evaluation.

Alloy history—The 9Ni-4Co alloy steels, on the market for almost three years, are available from Republic in all commercial shapes and forms. The HP 9-4-25 to be used in the roll extruded case program consists of 8% Ni, 4% Co, 0.25% C, 0.45% Cr and 0.45% Mo.

The technology of 9Ni-4Co alloy steels is based on the well-established background of carbon-bearing steels—normally referred to as quenched and tempered steels. HP 9-4-25 is a lower carbon variety. Republic Steel experts say it is typified by a high strength-toughness combination. Particularly, it demonstrates a potential to be welded in restraint without pre-heat or post-heat operations at a strength level of 200,000 psi in sections up to 2 in. thick.

The weld metal impact toughness in the tungsten inert gas process exceeds those reported for 200,000 psi 18 Ni-Co-Mo maraging steel, Republic metallurgists say joint efficiencies of better than 95% are the rule rather than the exception.

The steel alloy family can be air-melted or vacuum-melted. Quality of the steels, especially toughness and fatigue characteristics, can be significantly improved when these steels are produced by the vacuum-carbon-deoxidation practice.

Other melting practices can be used where the requirements are less stringent. This is true with the low-carbon steels, in which the inherent toughness of the alloys may obviate the need for special melting.

For HP 9-4-25 steel, as with other

construction alloy steels, the unnotched fatigue endurance limit is about 50% of the ultimate tensile strength. Republic researchers say that at strength levels of 200,000 psi, the ratio of fatigue strength to ultimate tensile strength was found to be greater than ½.

Stress corrosion cracking is a major limitation of high-strength steels in certain environments. Republic data in this are limited to those effects produced by a 3.5% NaCl solution.

When loaded to 80% of the yield strength, HP 9-4-25 specimens showed no failure after 1,000 hrs. of exposure to the salt environment. The exact time for failure is not yet known.

Roll extrusion—The NTW proprietary process produces elongated cylinders from small blank rings. The actual work under the UTC contract will be performed on a massive roll extrusion machine sunk some 40 ft. into the floor at NTW Missile Engineering.

The machine was designed by NTW and built under a $2.6-million award from the Manufacturing Technology Div of the Research and Technology Div., Air Force Systems Command.

In operation, metal ring blanks—welded or forged—are gripped by a fixture. Three rollers are mounted on a central shaft and positioned opposite a massive holding fixture enclosing the die ring. The workpiece rotates and is pulled downward while the rollers press the metal against the ring die.

Pressure on the rollers is achieved by a wedge system that forces each roller against the workpiece with equal pressure. The machine can handle ring blanks from 90 to 160 in. in diameter and produce cylinders up to 20 ft. long.

Each of the three rollers can exert up to 1.2-million-lbs. force against the workpiece. Total pulling force is about 6 million lbs.

Weaving eliminated—NTW is now installing auxiliary rollers on the extruder. These will act as steadying units in the extrusion process, eliminating a weaving phenomenon discovered while processing some D6A steel. The steel blank had hard spots in it and as the rollers passed these, a weaving motion was imparted in the center column. The part still came within blueprint specifications but inherent accuracy of the unit was impaired.

The flat-faced steadying rollers are being installed under Air Force funds and will be used in the HP 9-4-25 development contract.

A small ring, 12 to 18 in. high, will first be extruded in the HP 9-4-25 program for metallurgical evaluations. Then the roll-and-weld blank from Westinghouse will be inserted into the unit.

The original blank from Westinghouse will be 120-in. in diameter and 42 in. high. In eight passes the roll extruder will work this ring into a thinner-walled cylinder some 129 in. long.

NTW has had some experience with HP 9-4-25 in its 20 in. roll extruder. About a year ago, the firm extruded a small cylinder of HP-9-4 steel that had been rolled and welded. The weld effectively disappeared in the "vicious" metalworking process.

Roll extrusion works weld completely into the parent metal in many cases. The process so brutally works the metal that any major flaws tend to be exposed. It is feasible to cut out the affected area, weld a patch back, and rework the weld into the parent metal. ■

MOL To Cause Shift in Case Fabrication

There is a change in specifications on the *Manned Orbiting Laboratory (MOL) Titan III-C* solid motor procurement essentially eliminating longitudinal welds in the expensive pressure vessels.

Some 133 segments will be needed for the *MOL* launch vehicle. All must be fabricated by processes other than roll-and-weld. Westinghouse Electric Corp.'s Rocket Motor Case Dept., working with Ladish Co., is developing one approach to eliminate the longitudinal weld in the cylindrical segment sections through rolled rings.

A second approach is cold shear-forming, specifically roll extrusion. NTW Missile Engineering has a production ability in this area with its roll-extruder. Ladish has built its own roll-extrusion unit and has already supplied a seamless center section to Westinghouse. This unit has been hydrotested.

A third firm in the seamless fabrication field is J. W. Rex Co., noted for its heat-treating capability in weapons systems programs. The Rex equipment has not yet been disclosed but there are technical problems involved. Rex has the heat-treating art as well as the steel alloy involved. Ladish D6 requires heat treating.

No decisions or contracts are yet final in this matter. The manned aspect of *MOL* is undoubtedly the major reason for the attempt to eliminate the longitudinal weld in the solid strap-ons to the *Titan III-C*.

HEAT-TREATMENT	Austenitized at 1,550° F, oil or water quenched, tempered at 1,000° F.
PLATE THICKNESS:	½", 1", 2"
YIELD STRENGTH:	180-195 ksi
ULTIMATE TENSILE STRENGTH:	190-210 ksi
REDUCTION IN AREA:	55/65%
ELONGATION in 1 in	13/16%
IMPACT: Charpy V-notch	At rm temp 35/50 ft-lb −100° F 30/45 ft-lb −320° 20/30 ft-lb
Fatigue Pre-Carcked (W/A): V-notch Charpy	3,000/4,200 in-lb/in^2
PLANE STRAIN FRACTURE TOUGHNESS (K$_{IC}$)	125-165 psi-in$^{1/2}$
WELDABILITY:	Tungsten inert gas process (TIG) up to 100% efficiency in plates of up to 2-in thickness Other welding processes are under study
Weld metal yield strength:	175/195 ksi
Weld metal ultimate tensile strength:	195/210 ksi
Charpy V-notch impact of weld metal:	At rm temp 30/45 ft-lb At −100° F 30/40 ft-lb
K$_{IC}$ of weld metal:	120/150 psi-in$^{1/2}$
W/A of weld metal:	2,500/3,500 in-lb/in^2
ENDURANCE LIMIT: Smooth bar	10^8 cycles 95-110,000 psi
STRESS CORROSION CHARACTERISTICS:	No failure in 1,000 hrs after an exposure in a 3.5% NaCl solution

Nominal range of properties of HP 9-4-25 plate.

Nominal Chemical Analysis: C:0.25 Ni:8 Cr: 0.5 Mo: 0.5 Co: 4

Heat-Treatment*	Y.S. ksi	U.T.S. ksi	R.A. %	Elong. %	CVN Ft-lbs RT	CVN Ft-lbs −80	W/A in-lb/in^2	K$_{IC}$ ksi in$^{1/2}$
Oil or water	165	300	48/55	12/14	25	—	—	—
Air-cooled	170	260/270	52/56	12/14	34	30	1,200/1,300	—
Oil→400° F	185/195	225/235	58/63	13/16	30/40	—	—	100/120
Oil→1,000° F	180/195	190/210	60/65	13/15	35/55	—	3,000/3,700	125/150
Air→1,000° F	180/185	200/210	60/65	17/19	45/55	45	1,500/2,000	—

*Standard Heat-Treatment: 1 hr 1,600° F→A.C.→1 hr→1,500° F→quenched, then tempered as indicated

Weld Joint Efficiency: Y.S./>95% U.T.S./≧100% CVN/>80% W/A/>75%

Typical properties in 0.5 in. to 1 in. HP 9-4-25 steel plate.

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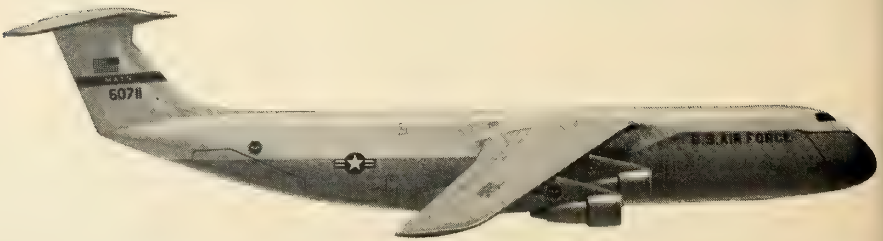

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Aviation Safety
Analysis
MAINTAINABILITY
OPERATIONS RESEARCH
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Japan Moves Toward Launch Of Home-Built Satellite in '68

TOKYO—Japan's plan to orbit its first satellite by early 1968 is progressing on schedule.

The 56-in.-dia. solid motor to be used as the booster for the launch vehicle, *Mu 4,* has been successfully test-fired. The control system, which will guide the launch vehicle into a horizontal position preparatory to orbiting the satellite, has been completed and successfully tested in flight. The prototype of the scientific observation satellite is also nearing completion.

The satellite is scheduled for lanuch during Fiscal Year 1967 from Kagoshima Space Center in Kyushu by the University of Tokyo's Institute of Space and Aeronautical Science. All the rocket and satellite components are being supplied by Japanese firms. Cost for the 1968 satellite launch is estimated at about $1,400,000.

Launch vehicle—The four-stage *Mu 4* launch vehicle will employ a solid fuel, probably ammonium perchlorate suspended in a matrix of polyurethane, for the first three stages. The final stage will be powered by hydrogen peroxide thrusters. *Mu 4,* 72 ft. long and 56 in. in diameter at the base, is designed to develop a thrust of over 400,000 lbs. Four vernier rockets will be attached to the booster.

Late last month, University of Tokyo space engineers test-fired the *Mu* booster, which successfully developed a thrust of about 200,000 lbs. Test flight of the *Mu 1,* with the same configuration as the *Mu 4* but with dummies for upper stages, is scheduled for early next year.

Details of the vehicle design have not yet been finalized. But the planned design includes a payload capability of up to 220 lbs. into a 300-mi. orbit. The vehicle will also be capable of probing deep into the outer Van Allen radiation belt, at altitudes of more than 10,000

Construction of launch facilities for Mu vehicles at the Kagoshima Space Center will be completed in early 1967. Rockets are fired eastward toward the Pacific.

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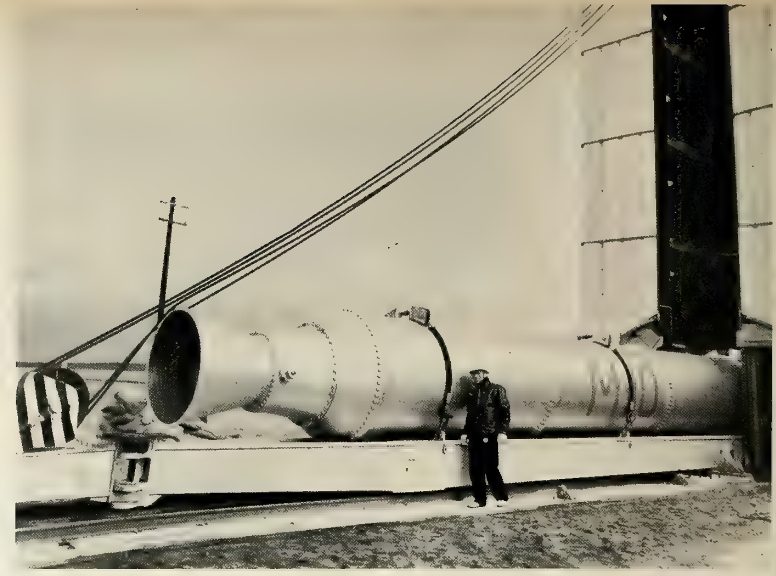


Four-stage Mu 4 will be used to orbit Japan's first satellite in 1968. The solid-fueled spacecraft is 72 ft. long, 56 in. in base diameter.

miles. (*Mu's* predecessor, the *Lambda* series, holds a record altitude of 700 miles.)

Control system—Eight hydrogen peroxide thrusters will power the launch vehicle's final stage. These are designed to guide it into a horizontal position with the help of gyros as a prelude to releasing the satellite into orbit.

University of Tokyo scientists plan to orbit Japan's first satellite using only this control system and without any conventional rocket guidance system. Because of this unprecedented nature of the plan, critics have expressed doubts as to whether it will succeed. The control system, however, was tested with success during the recent flight of a *Kappa 10* vehicle.

No control system will be used for the first three stages of the *Mu.* However, for flight stabilization, the first stage will have tail fins, and the second and third stages will be maneuvered in flight with special spin motors.

Satellite—Following completion of prototype development, the satellite will be tested in a space chamber early next year.

The payload will consist of instruments for observation of cosmic radiation, solar noise, and ionospheric conditions. Ionospheric probes, originally developed by Japanese scientists and successfully used in past observations by sounding rockets, are expected to be used to measure electron and ion density and electron temperature.

Estimated cost for the satellite itself ranges from $300,000 to $400,000.

The spacecraft will weigh about 150 lbs., slightly lighter than the Russian *Sputnik I.* The shell, made of light metal and plastic materials, will be a near-spherical polyhedron. About 5,000 solar cells will supply power to the payload. Flying in a 300-mi. orbit, the satellite will have an orbital inclination of 31 degrees. Period will be 90 minutes and estimated lifetime, one year.

Pulse code modulation (PCM) is expected to be used for the telemetry system.

Ground support—Construction of the launch pad for *Mu* vehicles is underway at Kagoshima Space Center—the world's only rocket center located on hills. Tops of the hills have been leveled with dynamite and bulldozers. All rockets are fired eastward toward the Pacific.

All ground suport facilities for the satellite launch will be completed by early 1967. Though the space center has tracking facilities, arrangements have yet to be made with satellite tracking stations abroad to track the first satellite.

Budget—This year, University of Tokyo scientists are spending $7 million for their space project. They hope to receive an annual budget of up to $12 million between next year and 1970. During this period, they plan to orbit seven more satellites following the first launch in 1968.

Another Japanese satellite project is a plan of the Science and Technology Agency's National Space Development Center to orbit a communications-navigation satellite by 1970. Including this project, the budgetary requirement for Japan's space efforts between 1966 and 1970 is expected to reach $140 million in total. ■

Germany Joins Canada, Britain In Drone Task

THE REPUBLIC of Germany has become the third partner in a program to develop a Canadian-designed surveillance drone.

The West German government will pay one third of the program's total cost, according to C. M. Drury, Canadian Minister of Industry. The drone system, initally known as the CL-89, has been a joint Canadian and British project.

The wingless drone is now designated the AN/USD-501. It was designed by Canadair, Ltd., Montreal, a subsidiary of General Dynamics. It is to provide tactical information in forward battle areas. Propelled by a jet engine, which provides speeds close to supersonic, it is missile-shaped and approximately 8 ft. long.

It is launched from a mobile launcher and uses a booster to gain altitude and operational speed rapidly. The drone follows a preselected course and can accurately photograph terrain features and military equipment before returning to base. Upon return, the engine cuts off and a parachute floats the drone to the ground for re-use.

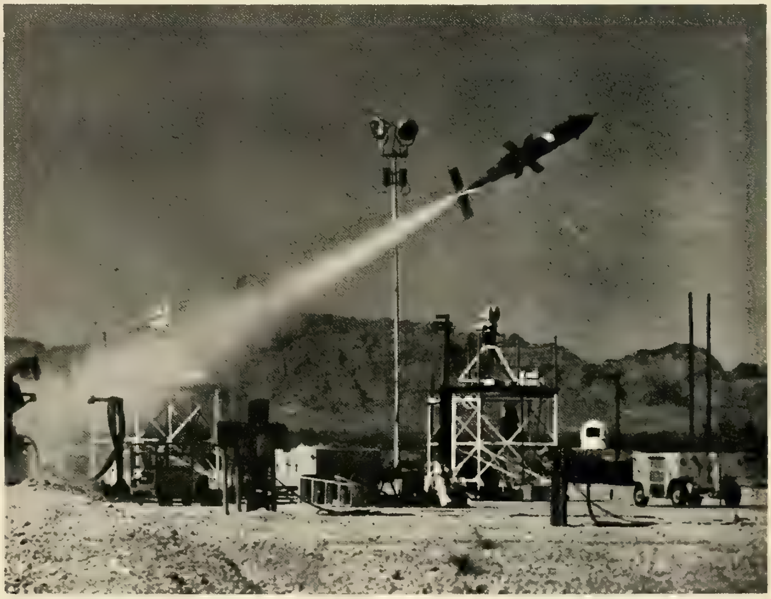
Canadair says the drone can be used for target acquisition, damage assessment and surveillance. The firm says one of the system's most valuable characteristics is its capability to develop the pictures taken over the target as it returns to base.

The British and Canadian governments announced their collaboration in developing the drone in June, 1963. It was later announced that the U.S. Army would provide firing-range facilities at its Yuma, Ariz., proving grounds.

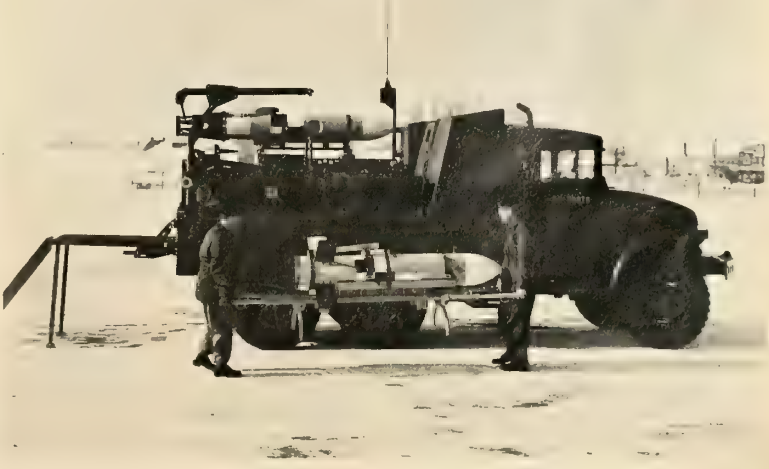
As development progressed, West Germany expressed interest in the project, and in mid-1965 a team of experts from the German Defense Ministry visited Canadair to see the drone development program. Discussions with the Canadian government were held at that time aimed at the possibility of German cooperation in the program and procurement for German forces.

Germany then became a full partner with Canada and Britain in further development late last month. ■

The AN/USD-501 surveillance drone system is shown just after separation from its booster rocket. Germany, Canada and Britain have joined in drone's development.

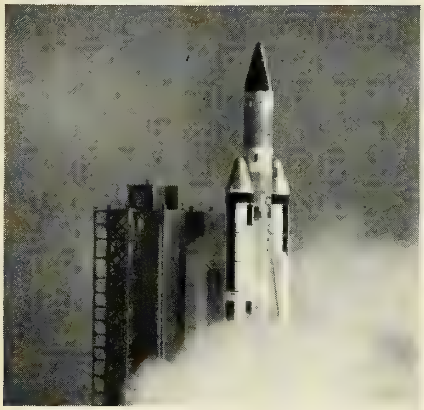


ABOVE: Drone leaves mobile launcher in test firing. The system is recoverable, launched by booster rocket, and lands by parachute cushioned by air bags on returning from a mission. BELOW: Canadian soldiers load mobile launcher with Canadair-designed drone.

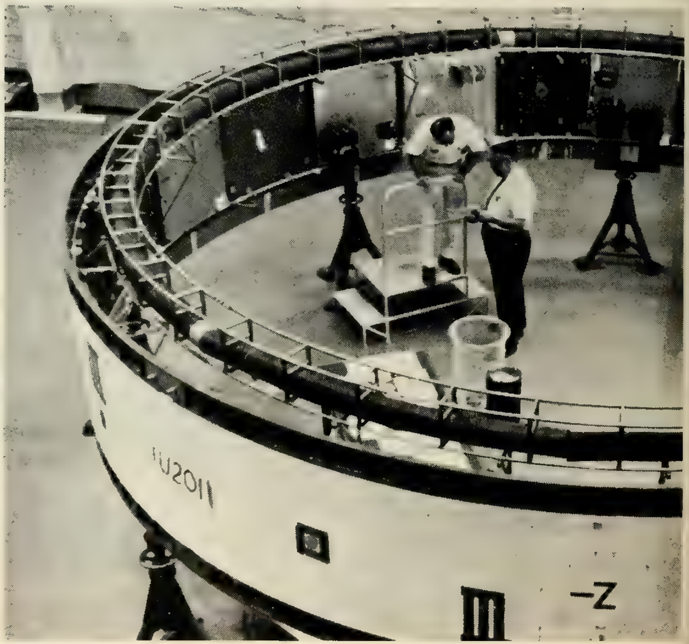


Tackling jobs like these takes systems know-how

- ☐ Steer Titan launch vehicles from pad to orbit
- ☐ Build a nerve center for Saturn launch vehicles
- ☐ Solve down-to-earth problems from space
- ☐ Memorize all the Gemini flight plan alternatives



Steering Titan launch vehicles from pad to orbit. ☐ This is the job for a compact, rugged IBM computer, a key element of the Titan III guidance system. It's from a line of IBM ASC-15 guidance computers that have flown more than 50 successful missions aboard Saturn I, Titan II and Titan III-A. ☐ Before a mission, IBM's computer checks instruments and controls. During flight, the rugged computer generates signals to correct roll, pitch and yaw to keep the vehicle on course. ☐ This IBM computer withstands the thrust of rocket blast-off and temperature extremes. And its record proves that it's tough, reliable and accurate.



Building a nerve center for Saturn launch vehicles. ☐ Since April, 1964, IBM has been lead contractor for this part of NASA's Saturn launch vehicle program. This is a management assignment to construct Instrument Units for Saturn 1B and Saturn V which are being developed under the direction of the Marshall Space Flight Center. ☐ The Instrument Unit is Saturn's control center. Located between the Apollo spacecraft and the upper stage of a Saturn vehicle, it controls and guides Saturn's first, second and third stages before releasing Apollo for its lunar flight. ☐ IBM's job includes designing and manufacturing data adapters and computers for the Instrument Unit, plus total systems integration and checkout of the more than 50 electronic units that make up the Saturn launch vehicle.

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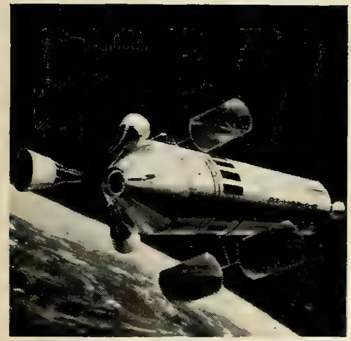

Solving down-to-earth problems from space. ☐ Orbiting space stations 200 miles high will provide a new point of view for the study of earth resources, weather patterns and crop yield. With this information, scientists will be able to recommend action to avert famine, flood and disease. ☐ IBM's job is to define these space station experiments for NASA. IBM simulation labs are developing new techniques to be used in surveying the earth from orbiting spacecraft. And IBM scientists are presently studying the problems and recommending the best sequence of experiments for space flights of the future.

Memorizing all the Gemini flight plan alternatives. A massive assignment. However, at NASA's manned spacecraft center in Houston, Texas, 5 powerful IBM 7094-II's—along with one of the world's largest memories, the IBM 2361 Model II Direct Access Core Storage Unit—can accomplish this and much more. As fast as far flung outposts across the world transmit their real-time in-flight data on each Gemini flight, IBM computers are analyzing the data . . . storing it . . . forwarding it to the NASA flight controllers for decision . . . and building the increasing store of facts and data so necessary for the first flight of American astronauts to the moon.

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Tests Set To Define Landing Hazard

Data from Ames studies, missile impact craters and Ranger photos indicate surface layer of loosely bonded material

By Willard E. Wilks

RESEARCH in the coming year may give a more precise indication of the lunar landing hazard, according to NASA spokesmen.

The tests will involve simulated craters in the laboratory and missile impact craters at White Sands Missile Range, N.M. The missile impact craters are the same size as those in the higher-resolution *Ranger* photos.

Laboratory and field studies at both White Sands and NASA's Ames Research Center—coupled with *Ranger* data—show conclusively that the Moon's surface is composed of material with low cohesive strength, probably to depths of meters or tens of meters, researchers report. Some have indicated a belief that the lunar maria may be the least desirable landing areas.

Persuasive evidence—The most striking evidence for a lunar surface covered extensively with loose or weakly bonded material has come from recent investigation of impact craters at White Sands made by unarmed missiles. Lunar-size craters have been produced in a variety of surfaces, from very weakly cohesive sand to strongly cemented material.

Dr. William L. Quaide of Ames reports that the most notable evidence produced at the range is that impacts in surfaces with even very moderate strength produce ejected blocks of material of such size that they should be visible in the *Ranger* photos. But no such blocks have been found in the photographs, showing the lunar surface is not solid rock or strongly cohesive material.

Another piece of evidence is crater geometry. Both in the laboratory and at White Sands, rims of craters in loose, unbonded material are predominantly circular, well developed and smooth—matching those seen in the *Ranger* photos. Craters in rocks or strongly bonded material have irregular, sometimes elongate, rims.

The "tree bark" texture seen in all high-resolution *Ranger* pictures has also been matched recently in the Ames laboratory, which uses a gas gun firing projectiles into various materials in a large vacuum tank. A texture duplicating that seen in the *Ranger* photos results when slumping occurs in craters made in finely crushed quartz.

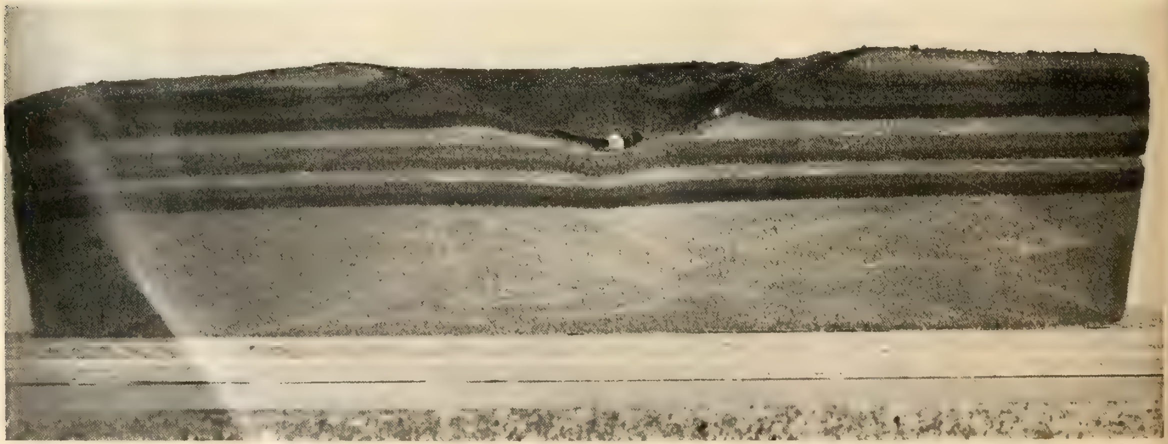
The White Sands results are regarded as particularly significant since there is always a question of whether information obtained with relatively small craters in the laboratory can be extrapolated to larger craters on the Moon. Ames reports the White Sands field studies have confirmed lab results.

Secondary craters informative—In the Ames work, secondary craters have proved to be an important and unexpected key to interpreting the *Ranger* photos and theoretically determining the nature of the lunar surface. Recent studies, both at Ames and White Sands, have shown that target strength is an important parameter in determining the geometry of a crater that is produced by low velocity impact.

While geometry of craters produced by hypervelocity impact (primary bodies) is insensitive to material strength of the target, the geometry of craters produced by low velocity (secondary) projectiles varies widely according to target material strength. Velocity of missiles impacting at White Sands is typical of lunar secondary impacts, and strength of the target material at White Sands varies widely, enabling study of the cratering process in different materials.

By measuring porosity and bearing strength of the various materials impacted at Ames and at White Sands, researchers expect to be able to estimate these characteristics for the lunar surface. The studies to date show that the

Crater made by spherical glass projectile traveling at 0.75 km./sec. and impacting at 60° from left.



continuum of crater forms seen in the *Ranger* photos—from sharp, well-defined ones to faint, shallow craters—is not the result of different mechanisms of formation but of ejecta scattered over the Moon by continuing impacts.

The conclusion is that the lunar surface is overlaid by a blanket of loose ejecta created by impacts throughout lunar history. Part of the ejecta may be from explosive outgassing.

Quaide reports the cratering process study at Ames also is directed at producing a handbook that will instruct lunar astronauts in such things as where to drill to obtain the best samples of surface material from different depths. He points out the explorers will be limited in both time and power available.

Ames works detailed—Studies in the laboratory and field show the cratering process overturns material from lower depths so that it overlies surface material in a predictable pattern. Thus samples from different depths can be more easily obtained by knowing where to prospect along a crater profile.

At Ames, impact craters are made in targets composed of sand in multicolor layers or vertical columns. The sand contains a bonding agent, and the crater is cured in an oven after impact so it can be sectioned for study. Horizontal layered models reveal how material from different depths is overturned, and vertical column models show how material is sheared over the crater's diameter.

"At White Sands, we are setting up a very careful program of studying material strengths of different impact craters," Quaide reports. "We are preparing profiles of each crater, plotting its contour, mapping distribution of ejecta, studying the broken zone beneath the crater and digging in and examining deformation of beds." Prospective lunar astronauts will visit all types of craters available on Earth, including those at White Sands.

In another lunar study at Ames, researchers believe they already possess fragments of the Moon and are trying to trace them to a specific crater. The crater Tycho is the suspected place of origin of the tektites, Dr. Dean R. Chapman says. The tektites are found only in a streak across Australasia.

Chapman is engaged in a program to plot the Earth pattern of the objects and has a computer program to trace the tektites to a specific location on the Moon by reproducing their Earth-Moon trajectory following impact of the body that created them on the Moon.

Chapman says he has no doubt that the objects are re-entry bodies since similar objects produced under simulated re-entry conditions are virtually identical as to configuration and surface markings. ■

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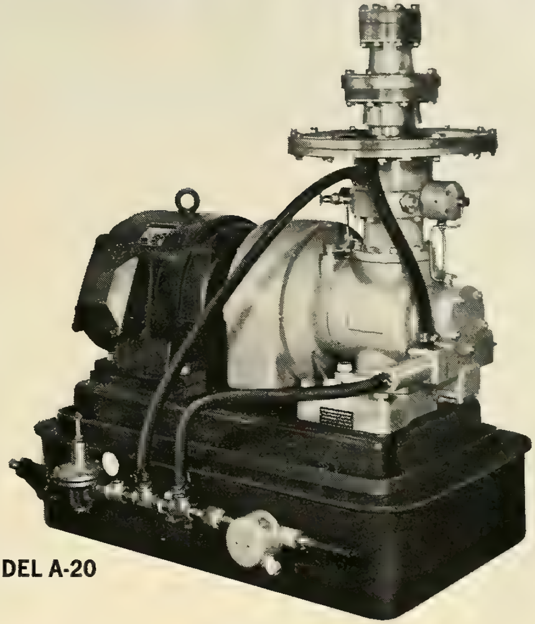

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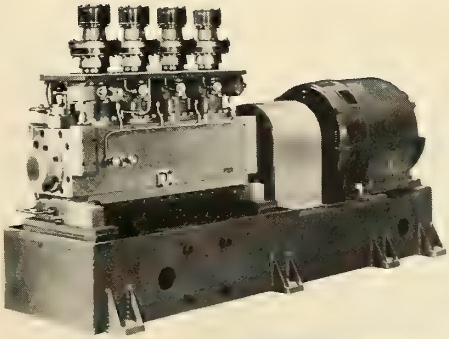

MODEL B-20

The B-20 Cryogenerator, like its counterpart the A-20, has been similarly designed with *cold* and *intermediate* take-offs. However, refrigeration capacity is four times that of the A-20 Model.

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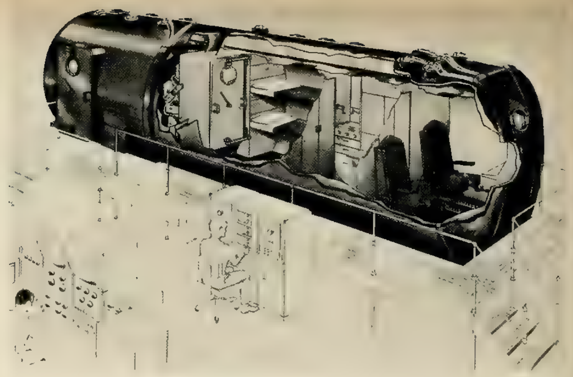
Helium Looks Feasible For Use in MOL Cabin



Artist's conception of simulator used in unprecedented helium/oxygen experiment at School of Aerospace Medicine.

AIR FORCE PHYSICIANS conducting a test of a simulated helium/oxygen spacecraft atmosphere for the *Manned Orbiting Laboratory* report that helium seems physiologically acceptable.

While the analysis is preliminary—full results will not be available until all data are reduced sometime in the spring—it would appear that there are no factors which would rule out the use of helium instead of nitrogen as a diluent gas for *MOL*.

Four Air Force officers emerged on Dec. 13 from the *MOL* simulator at the School of Aerospace Medicine, Brooks AFB, Tex., after a stay of nearly two months in the 70% oxygen, 30% helium environment at 5 psi.

Three of the four maintained their weight on the space-type diet, but one lost about 10 pounds. However, doctors said records showed that he did not consume the level of calories needed for the activity in the cabin, and that this appeared to explain the weight loss.

Diet included three solid meals a day, plus one liquid, milkshake-like supplemental meal being evaluated by the Air Force. However, the subjects of the experiment, perhaps the longest during which anyone has ever subsisted on a simulated space diet, were rather negative in their comments about the food.

The Air Force experiment again indicated that when helium is used with relatively high percentages of oxygen (compared with deep-sea experience) the difference in heat-transfer is not as great as has been theorized.

However, in other helium/oxygen experiments conducted at The Garrett Corp. and Douglas Aircraft Co.'s Missile and Space Systems Div., it was concluded that astronauts could operate at higher ambient temperatures, thus saving power and weight in life support systems (M/R, Oct. 25, p. 39.)

The School of Aerospace Medicine group, which has conducted two other helium/oxygen experiments, at one-half atmosphere, said that there were no changes in thermal equilibrium of the subjects.

Temperature during the recent test was maintained at around 70 to 74°F, with relative humidity at about 35%. The men operated their own temperature control system to arrive at individual thermal comfort levels.

Results of body and skin temperature curves, which were recorded before and after exercise, will better define this problem.

Medical tests—The tests performed during the experiment were designed to cover every conceivable aspect of the human system which might be affected.

Thus far, only negative, or normal, results are evident. The tests generally were made with clinical equipment, and the men themselves drew samples for blood, gas and waste analysis.

Gathered during an eight-day pre-altitude period were measurements of urine electrolyses, steroid catechols, energy balance, hematological studies, renal function, baseline exercise information, respiratory function, lung compartment data, body water, plasma vol-

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ume, body volume measurements, tilt table and treadmill data, and nutritional and bacteriological data.

A new dental experiment was included in this test, in which the Air Force doctors sought to determine what the minimum standard for spacecraft dental hygiene would be. The men brushed their teeth three times a day with distilled water, and a fourth time with a consumable toothpaste.

The work-rest schedule included eight-hour sleeping periods each day and three 20-minute exercise periods on a bicycle ergometer.

Program modified—Although the experiment was planned to last 60 days at altitude, Dr. B. E. Welch, chief of Environmental Systems Branch, changed the program so that the last four days of confinement would be conducted at ground level. During this time (Dec. 9-13) post-experimental data were obtained in the simulator at ground level.

After their emergence from the simulator Monday, the subjects began yet another week of extensive post-experimental physical evaluation.

The space cabin simulator is a cylindrical, double-walled, low-pressure altitude chamber 30 ft. long and 9 ft. in diameter, weighing 30 tons. The 20-ft. main test cell has three compartments—a cockpit or control section, a work area including galley and environmental control equipment, and a rest area. ■

Little Difference Found in Effects of Protons, X-Ray

FURTHER DEFINITION of the biologic effectiveness of proton radiation as it may be found in space indicates that 138-Mev protons and 2-Mev X-rays produce essentially identical findings, except for more pronounced gastrointestinal signs after proton irradiation.

The information came from a continuing program at the Air Force's School of Aerospace Medicine to determine the biological effects of high-energy protons which may be able to penetrate even the thickest spacecraft shielding.

SAM scientists have exposed large numbers of primates to a wide spectrum of proton radiation at various cyclotron facilities (M/R, Nov. 15, p. 34). Proton radiation is being compared with X-rays and gamma radiations with the same linear energy-transfer characteristics to assess relative biologic effectiveness (RBE).

HERCULES

Safe Way to the Surface

Present-day deep-running submarines have brought an increased need for an effective method of escape in critical situations. Long concerned with this problem, the survival system branch of the U.S. Naval Applied Science Laboratory joined Hercules engineers in developing an escape capsule capable of withstanding severe pressures during ascent.

Pioneers in development of rocket motor cases made from Spiralloy® filament-wound glass fibers, Hercules utilized the same material in the escape capsule shown here. The material when properly formed provides a structure lighter than aluminum and stronger than steel.

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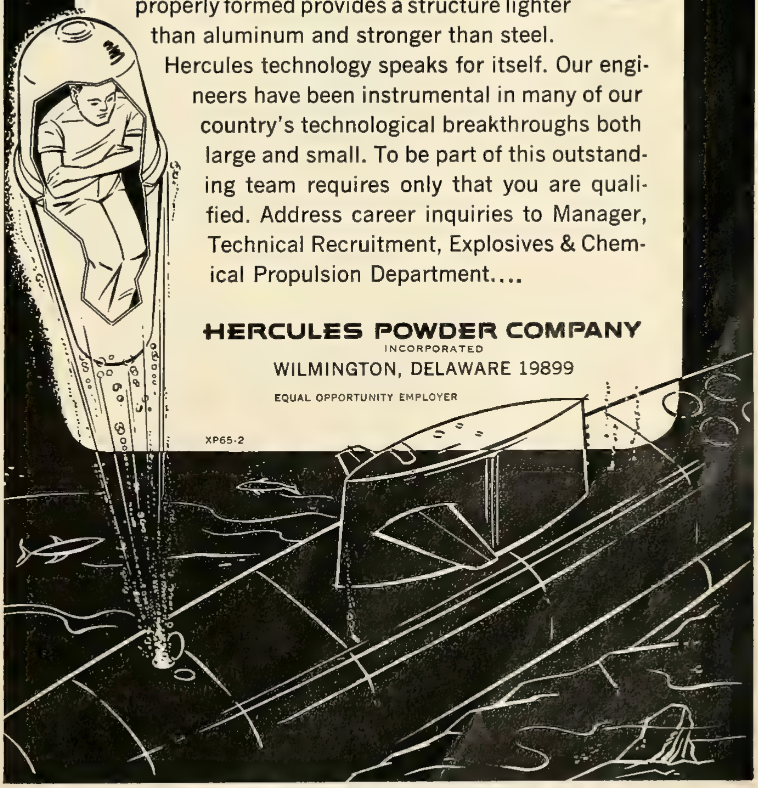

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The Industry Week

Mergers and Acquisitions

Bendix Corp., Detroit, has completed purchase of the P&D Manufacturing Co., Inc., Long Island City, N.Y., by issuing 117,000 shares of Bendix stock. P&D manufactures ignition parts and grip controls. . . . *The Potter Co., Skokie, Ill., has acquired Chem-Electro Research, Los Angeles subsidiary of Products Research Co. CER manufactures ceramic capacitors for missile/space applications.* . . . Information Sciences, Inc., Atlanta, Ga., has purchased the assets and liabilities of Computer Services, Inc., Montgomery, Ala. Information Sciences was established in July as a subsidiary of Brown Engineering Co., Huntsville, Ala. . . . *Argus, Inc., Chicago manufacturer of photographic and optical equipment, plans to purchase a substantial position in the Te Co., Santa Barbara, Calif. Te developed and built the optics for the Canopus star-tracker used in the Mariner IV Mars probe.* . . . Mark Products, Inc., Houston, has acquired the physical assets of the Cable Div. of OECO Corp., Portland, Ore. The division will be moved to Texas next month. Cable Div. manufactures umbilical cables used in the *Gemini* spacecraft and *Minuteman* and *Polaris* missiles. . . . *Aerotherm Corp., Palo Alto, Calif., has purchased the hyperthermal test laboratory and arc plasma facility formerly owned by Itek Corp.'s Vidya Div. in Palo Alto.*

New Activities

Martin Marietta Corp., New York City, has formed a Commercial Group, consolidating all the firm's commercial activities. Joseph E. Muckley has been named president and general manager of the new division. . . . *Beckman Instruments, Inc., Fullerton, Calif., has consolidated its analog and hybird computer operations into the firm's Systems Div.* . . . American Beryllium Div. of Loral Corp,. Sarasota, Fla., has opened a regional sales office in Waltham, Mass.

Facility Expansions

Radio Corp. of America, New York City, is planning a $3.2-million expansion of its semiconductor plant at Mountaintop, Pa. The move will add 86,000 sq. ft. of production facilities. . . . *Texas Instruments, Inc., Dallas, is moving manufacturing activities of its Semiconductor-Components Div. to new facilities in Sherman, Tex.* . . . Pennsalt Chemicals Corp., Philadelphia, has announced plans for a major modernization and expansion of its chlorine-caustic plants in Calvert City, Ky., and Portland, Ore. The project will increase the plants' chlorine production capability to 550 tons per day. . . . *Union Carbide Corp., New York City, plans to build an automated warehouse at its South Charleston, W. Va., plant. Aerojet-General Corp's Industrial Systems Div. will design the facility. Completion is scheduled for 1967.* . . . Itek Corp., Lexington, Mass., will construct an 88,000-sq.-ft. optics research and development building, adjoining its Lexington facility. Building and equipment will cost approximately $4 million. Completion is scheduled for early 1967. . . . *Crest Ultrasonics Corp., Trenton, N.J., has added 20,000 sq. ft. of manufacturing space to its present plant.*

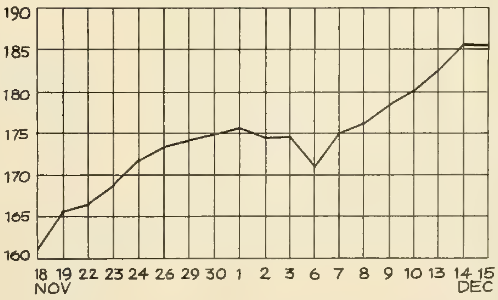
Potpourri

Sperry Rand Corp. and International Business Machines Corp. have announced an agreement on non-exclusive cross-licensing of all patents in the field of information handling. Both firms decline to give details, but the settlement "resolves all outstanding patent differences" between the two firms, a Sperry spokesman said. . . . *The United States Court of Customs and Patent Appeals has been asked to rule on patent rights on a particular laser development. R. Gordon Gould, former physics graduate student at Columbia University, has asked the court to declare that he first conceived of a version of the laser featuring parallel mirrors at opposite ends of a gas-filled tube. A patent application on the device was first filed by Dr. Charles H. Townes, Massachusetts Institute of Technology, and Dr. Arthur L. Schawlow, Stanford University, in July, 1958. Gould did not file an application until April, 1959. The patent was granted to Townes and Schawlow in March, 1960.*

Representatives Named

Scientific Control Systems, Inc., Dallas, has appointed Electronic Sales Associates, Inc., sales representatives for SCS's computer products in Delaware, Maryland, Virginia and the District of Columbia. . . . *Edgerton, Germeshausen & Grier, Inc., Boston, has named Eastern Instrumentation, Inc., to represent its product lines in Delaware, Maryland, Virginia, the District of Columbia, southern New Jersey and eastern Pennsylvania.*

Missile/Space Stock Index



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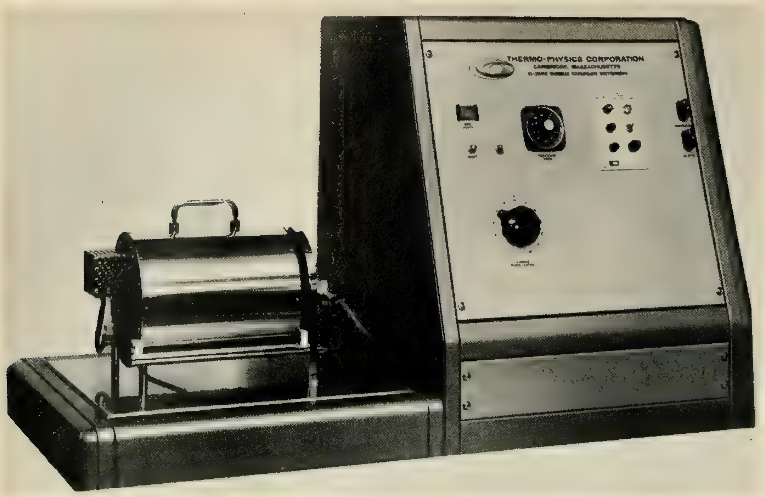

New Product of the Week: Thermal Expansion Instrument

A device for determination of thermal expansion of ceramics, metals, plastics and composites with an accuracy of ±2% has been announced by Thermo-Physics Corp.

The Model TE-2000 thermal expansion unit operates in a temperature range of 70° to 2,000°F and is basically a fused silica dilatometer. In operation, sample dilation differentials are transmitted from the furnace uniform temperature hot zone to a thermally shielded LVDT via a fused silica tube and extension rod. A special sample holder is used which allows various diameter samples to be held in a fixed attitude with respect to the push rod and tube.

Optional features include inert gas or vacuum environment (10^{-2} or 10^{-6} torr) and a temperature range of —300° to 3,000°F. Power supply is 110v ac, 2.5 kw, 60 cps.

Circle No. 151 on Subscriber Service Card

Gas Laser

Optics Technology, Inc., is marketing a continuous gas laser, designed for both educational and industrial applications.

The Model 170 AC produces a beam of collimated light in the visible red at 6,328 Angstroms. Laser power is over 0.3 milliwatts to TEM_{00} (uniphase) mode guaranteed after 100 hours. Beam divergence is less than 0.4 milliradian half angle in TEM_{00} mode. Beam diameter is approximately 1 mm at exit aperture. Input is 115v ac, 60 cps.

Circle No. 152 on Subscriber Service Card

Oxygen Seal

A mechanical packing design to seal against oxygen in all forms has been developed by Chesterton Packing & Seal Co.

The Style 324-OX packing is braided entirely with 100% pure Teflon filament. It is characterized by a low coefficient of friction and tensile strength 30 times that of ordinary packings, the firm says. The material is available in valve stem sizes from ⅛ to ½ in.

Circle No. 153 on Subscriber Service Card

Microwave Switch

An X-band switch, using a single diode whose stored charge is less than 2.0 picocoulombs, has been announced by Somerset Radiation Laboratory, Inc.

The Model X440 can be turned on and off in less than 0.1 nanosec. and has an isolation of more than 30 db. Insertion loss is less than 3.0 db (1.0 db with external tuning) at 9 gc.

Either polarity can be selected by attaching the shorting cap to either of the two BNC connectors. Percentage modulation is more than 94%; waveguide is 0.9 x 0.4 in. I.C. (8.2 to 12.4 gc nominal range).

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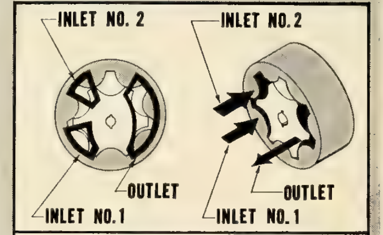

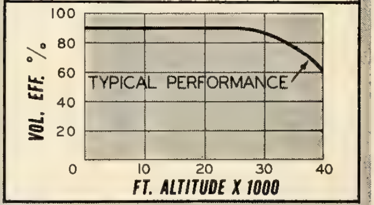

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AIR FORCE

$15,000,000—**RAND Corp.**, Santa Monica, Calif., for studies and research on aerospace power.

$10,500,000—**Avco Corp.**, Cincinnati, Ohio, for procurement of additional early warning system equipment.

$2,955,000—**Collins Radio Co.**, Dallas, Tex., for continued production of communications equipment.

$2,924,970—**Cornell Aeronautical Laboratories**, Buffalo, N.Y., for analysis and evaluation of penetration aid effectiveness.

$1,800,000—**General Telephone & Electronics Corp.**, New York City, for continued testing of electronic equipment to monitor, target and launch *Minuteman* intercontinental ballistic missiles.

$1,660,483—**International Business Machines Corp.**, New York City, to make components of electronic data-processing equipment.

$1,140,000—**Ford Motor Co.**, Newport Beach, Calif., for continued test and evaluation work on missile fuzing and arming systems.

$1,040,000—**Teledyne Industries, Inc.**, Garland, Tex., to make seismometers.

$1,000,000—**Thiokol Chemical Corp.**, Bristol, Pa., for continued research and development work for the stage 1 *Minuteman* motors.

$766,000—**Radio Corp. of America**, Astro-Electronics Div., Princeton, N.J., continued work on a classified program.

$195,820—**Hughes Aircraft Co.**, Culver City, Calif., for additional facilities to support production of the *Falcon* missile, F4 aircraft airborne missile control subsystem.

$194,830—**Douglas Aircraft Co.**, Missile & Space Systems Div., Santa Monica, Calif., for section switch assembly applicable to the *Genie* rocket.

$86,065—**American Science and Engineering, Inc.**, Cambridge, Mass., for research directed toward the analysis of satellite and rocket data.

$57,500—**Collins Radio Co.**, Dallas, Tex., for research analysis and study to determine the feasibility of a lightweight tactical, low frequency antenna for the LORAN-D transmitter complex.

$50,360—**Air Products and Chemicals, Inc.**, Allentown, Pa., for oxygen supply system for manned space enclosure.

$30,000—**Temple University**, Research Institute, Philadelphia, Pa., for development of a rocket payload for the release of barium vapor.

ARMY

$9,891,873—**Motorola, Inc.**, Military Electronics Center, Chicago, to manufacture mortar proximity fuzes.

$2,450,000—**Douglas Aircraft Co.**, Santa Monica, Calif., initial segment of $3,170,000 contract for work on a classified research project.

$1,600,000—**Raytheon Co.**, Bedford, Mass., for development of self-propelled *Hawk* modification to the *Hawk* missile system.

$469,117—**Hughes Aircraft Co.**, Fullerton, Calif., for equitable adjustment for engineering changes and packaging, packing and marking changes to the satellite communications terminal.

$455,000—**Chromcraft Corp.**, St. Louis, Mo., for 2.75-in. aircraft rocket launchers.

$64,866—**Melabs**, Palo Alto, Calif., to study the feasibility of developing high-speed techniques for remotely tuning a 25-watt transmitter over 100- to 400-mc range.

$50,000—**ITT Gilfillan, Inc.**, Los Angeles, for feasibility study of an anti-arm decoy.

NAVY

$9,119,701—**Universal Match Corp.**, Ferguson, Mo., to manufacture missile launchers.

$6,900,000—**ITT Corp.**, New York City, letter contract for radar systems

$5,362,026—**North American Aviation, Inc.**, Mcgregor, Tex., for production of motors for *Sparrow* and *Shrike* missiles.

$3,823,657—**General Precision, Inc.**, Tarrytown, N.Y., to manufacture training sets for the Phantom II weapons system in Binghamton, N.Y.

$2,892,606—**Douglas Aircraft Co.**, Santa Monica, Calif., to make electronics equipment.

$1,298,010—**Western Electric Co.**, New York City, for engineering work on the *Terrier*, *Tartar* and *Talos* air-defense missile systems.

$1,249,873—**General Instrument Corp.**, Hicksville, N.Y., to make classified electronic equipment,

$36,672—**General Electrodynamics Corp.**, Garland, Tex., for *Walleye* lens assembly.

NASA

$47,655,103—**TRW, Inc.**, Systems Group, Redondo Beach, Calif., to continue work on the *Gemini-Apollo* project to land a man on the Moon.

$1,000,000—**Radio Corp. of America**, West Coast Div., Van Nuys, Calif., an increase in contract for the *Saturn* computer program.

$983,000—**Bendix Corp.**, Teterboro, N.J., to build a star tracker for Goddard Space Flight Center *Advanced Orbiting Solar Observatory*.

$700,000—**Graduate Research Center of the Southwest**, Dallas, Tex., from Ames Research Center for cosmic ray experiment for Project *Pioneer*.

$215,000—**Honeywell, Inc.**, Minneapolis, Minn., from Goddard Space Flight Center for design, development and fabrication of a nonredundant breadboard spacecraft digitized controller.

$175,955—**Clevite Corp.**, Electronic Research, Cleveland, Ohio, from Lewis Research Center for study of thin-film large area of photovoltaic solar energy converters.

$137,223—**Wolf Research & Development Corp.**, West Concord, Mass., from Electronics Research Center for mathematical analysis and computation services.

$99,481—**Rocket Research Corp.**, Seattle, Wash., from Goddard Space Flight Center for development and fabrication of *IMP-E* attitude control thruster system.

$83,962—**Lockheed Aircraft Corp.**, Marietta, Ga., from Kennedy Space Center for supplies and components for *Saturn V* Q-ball cover removal system.

$46,854—**Sperry Rand Corp.**, Sperry Rand Research Center, Sudbury, Mass., from Electronics Research Center for ultra-high-temperature electronic measuring technique.

$44,385—**GCA Corp.**, Bedford, Mass., from Electronics Research Center for atmospheric nitric oxide measurement techniques.

$35,800—**Dunlap and Associates**, Darien, Conn., from Electronics Research Center for investigation of the capabilities of peripheral vision for improving information transfer to operators involved in complex control tasks.

$35,367—**General Precision, Inc.**, Aerospace Group, Little Falls, N.J., from Electronics Research Center for research to develop flight displays suitable for use under wide variations in ambient illumination level. Also $39,750 for continuation of beam alignment techniques based upon current multiplication effect in photoconductors.

INDUSTRY

$7,000,000—**Cubic Corp.**, San Diego, Calif., from **General Electric Co.**, New York City, to produce F-111A radar antennas.

$500,000—**Novatronics, Inc.**, Pompano Beach Fla., from the **Lockheed Aircraft Corp.**, Burbank, Calif., for a number of real-time spectrum analyzers for military aircraft installation to assist in submarine detection from the air.

$400,000—**Radio Corp. of America**, Communications Systems Div., Camden, N.J., increase from **Collins Radio Corp.**, Dallas, Tex., for VHF radio sets.

COMMUNICATIONS SATELLITE CORPORATION

$240,000—**United Kingdom General Post Office**, London, England, for research into certain aspects of satellite communications.

Spaco's broad spectrum of activity in design, engineering and manufacturing, such as ground support equipment designed and fabricated for NASA's space vehicle systems, offers qualified engineers opportunity to exercise their highest order of professionalism while working with daily challenge in the aerospace field. Career development and reward will be commensurate with background and demonstrated ability. ○ *Huntsville, cradled in the beautiful Tennessee River Valley, offers a congenial atmosphere for family living and family fulfillment. Qualified engineers are urged to investigate Spaco's unique opportunities in Aerospace Systems Engineering: Check-Out Systems analysis and design; Reliability Assurance operations and engineering; Design of Digital Systems and Equipment; Ground Support equipment design and systems analysis; Quality Assurance Engineering.*

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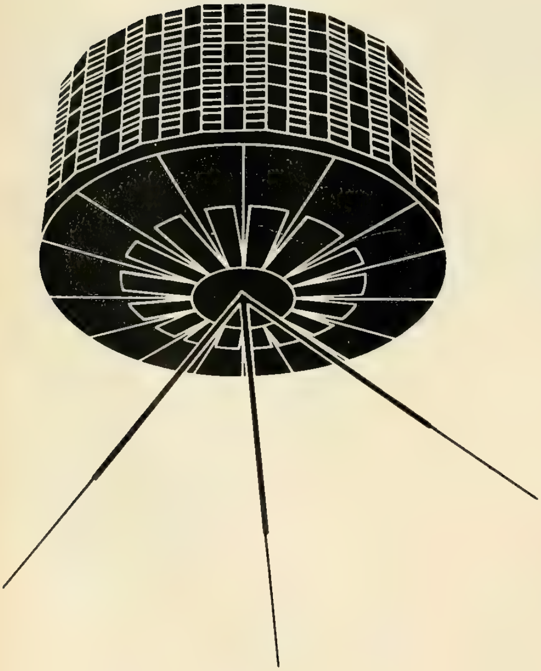
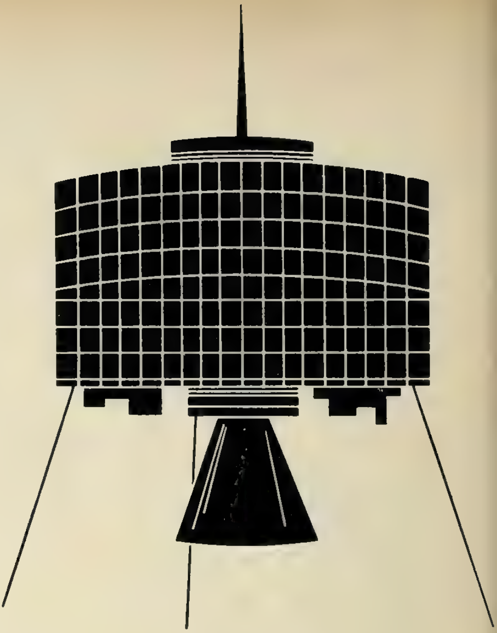
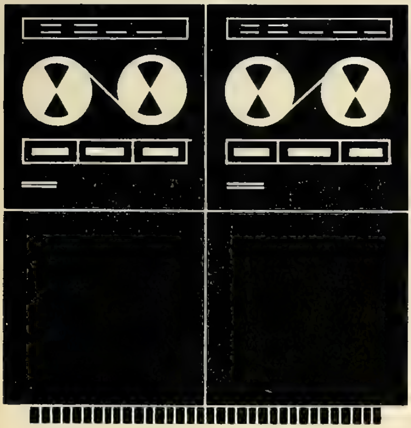
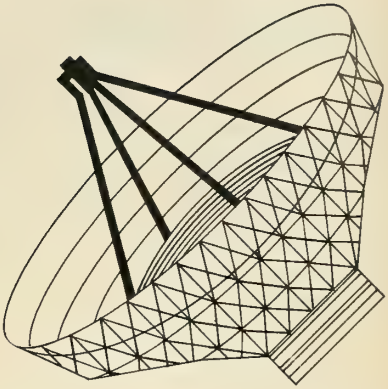




SPACE COMMUNICATIONS





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A Special Report on Space Communications will be published by MISSILES AND ROCKETS on January 31, 1966. This report will give comprehensive coverage of the use of advanced satellite systems for military and commercial telecommunications.

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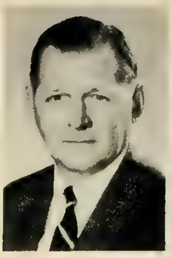
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KING

Einar M. Ramberg: Appointed division vice president of United Aircraft Corp., Hamilton Standard Div. **Richard F. Gamble** succeeded him as engineering manager. **Herman A. Michelson** has been appointed executive assistant to the division president.

Carl G. Holschuh: Appointed a vice president of General Dynamics Corp. He was formerly executive vice president and a director of the Sperry Rand Corp.

Wallace G. Grove: Named vice president, aerospace division, of Kaiser Aerospace & Electronics Corp. **Carlton K. Perkins:** Elected vice president, electronics division; **Robert L. Freistat:** Named vice president and controller.

Ralph D. King: Appointed a vice president of Lockheed Missiles & Space Co. He also became assistant general manager of the company's Space Systems Div.

Matthew S. Smith: Named president and chief executive officer of Special Devices, Inc. He is the author of a book entitled "Principles and Applications of Tensor Analysis."

Kendall Perkins: Named chairman of the Aerospace Technical Council for 1966. **Carl L. Sadler** has been named vice chairman. Perkins is vice president for engineering at McDonnell Aircraft Corp. Sadler is vice president of aerospace and defense products at Sundstrand Corp.

Donald C. Giles: Named president of the Air Reduction Co., Inc.'s Airco Industrial Gases Div. **James T. Mahoney,** previously vice president-administration of the Pure Carbonic Div., has been appointed executive vice president and general manager of that division.

George F. Senn: Appointed director, Engineering Directorate, U.S. Army Satellite Communications (SATCOM) Agency. **Robert E. Smith** is the new director of Mission Support for the agency.

Leo A. Carter: Elected a member of the board of directors at Tridair Industries. He was in charge of prototype development of the DC-6 and had managerial direction of the *Sparrow*, *Genie* and *Nike* missile programs at Douglas Aircraft Co., Inc.

Raymond C. Watson, Jr.: Named a vice president of the Brown Engineering Co. He will be responsible for the company's research laboratories, future programs office and other company organizations concerned with advanced systems and technologies.

Martin N. Chase: Named vice president for Washington area activities of Technical Operations, Inc. He will be responsible for Tech/Ops' Washington Research Center and the company's combat operations research group.

Dr. Henry D. Friedman: Named manager of the Smithsonian Astrophysical Observatory's data processing department. He will plan and coordinate data processing systems supporting the research projects of the Smithsonian's scientific staff and supervise the processing of observational data obtained by the Smithsonian's field stations.

William E. Osborne: Joined Huggins Laboratories as chief scientist. His initial project at the company will be the further development and refinement of an infrared perimeter surveillance system upon which he holds patents.

Dr. Jack E. McKee: Appointed a member of the Atomic Energy Commission's Advisory Committee on Reactor Safeguards. He is professor of environmental health engineering at California Institute of Technology, Pasadena.

H. Jospeh Markert: Appointed vice president, corporate planning, of the American Bosch Arma Corp. He will be responsible for corporate programs dealing with company development, internal growth and acquisitions.

Louis J. Frisco: Will head the Technical Services Laboratory at Raychem Corp. He was formerly director of Johns Hopkins University's Dielectrics Laboratory.

George B. Macfie: Appointed staff specialist in the Lundy Electronics & Systems, Inc., engineering department. He retired this year from the U.S. Air Force after 24 years of service.

Walter E. Sutter: Elected vice president and senior director of marketing at Page Communications Engineers, Inc.

missiles and rockets
THE WEEKLY OF ADVANCED TECHNOLOGY

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DECEMBER

132nd Annual Meeting of the American Assn. for the Advancement of Science, University of California, Berkeley, Dec. 26-31.

International Symposium on Differential Equations and Theory of Systems, sponsored by the Air Force Office of Aerospace Research, Brown University and the University of Puerto Rico, University of Puerto Rico, Dec. 27-30.

JANUARY

Winter Meeting of the National Society of Professional Engineers, Americana Hotel, Miami Beach, Fla., Jan. 5-8.

American Chemical Society National Winter Meeting, Phoenix, Ariz., Jan. 16-21.

Society of Plastics Engineers Regional Technology Conference, sponsored by the Cleveland Section, Sheraton-Cleveland Hotel, Cleveland, Jan. 20.

Third Coral Gables Conference on Symmetry Principles at High Energy, sponsored by the University of Miami, Air Force Office of Scientific Research, Atomic Energy Commission, National Aeronautics & Space Administration, National Science Foundation, and Office of Naval Research, University of Miami, Coral Gables, Fla., Jan. 20-22.

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Letter from the Editor

THE YEAR IS ENDING on a high note of triumph for the U.S. space program. Successful accomplishment of the rendezvous mission of *Gemini 6* and *Gemini 7* is strong assurance that the *Apollo* program can meet the requirements of one of the most difficult maneuvers necessary in setting man down on the Moon.

It also is a distinct first for the U.S. in the space competition with the Soviet Union. Cosmonauts Popovich and Nikolayev came within four miles of each other in twin flights on Aug. 2, 1962—as did cosmonauts Bykovsky and Tereshkova on June 19, 1963—but these in no way were an accomplishment of true rendezvous. The difference is quite apparent to anyone who followed the intricate maneuvers necessary to bring the two *Gemini* craft into formation. Even the Russians do not claim to have accomplished rendezvous on those early flights, although a misinformed weekly aviation magazine credited them with the achievement at the time.

Perhaps the most notable aspect of the twin *Gemini* flight was its aura of operational achievement. There was a definite atmosphere of maturity about the carrying out of the rendezvous mission. This was not a stunt; this was not experimental; this was, indeed, space operations.

The radio exchanges between astronauts Schirra, Stafford, Borman and Lovell were more laconic than might be expected of aircraft pilots on a commonplace formation mission. Whatever awards they win won't be for public speaking.

But if the pilots weren't excited, the public was. This mission caught the imagination of the nation and the world. This is not a factor to be underestimated with budget presentation just ahead.

It also is worth commenting on the role played by two unmanned space systems during the *GT-6* and *GT-7* flights. *TIROS* satellites enabled mission planners to keep track of the weather in critical areas around the world throughout the missions. Recovery photographs relayed from the carrier USS Wasp by the *Early Bird* satellite were remarkable in quality and filled in the next-to-last link in coverage of the flights. Final link, of course, is television from the spacecraft in orbit, something the Russians have accomplished ahead of the U.S.

As we glance backward in the traditional year-end review of this final 1965 issue, it seems hard to believe that at this time last year there had not been a manned U.S. space flight for well over a year and a half. The intense *Gemini* activity this year tends to obscure that. Yet hard decisions must be made in the months ahead if we are not to face a similar gap at the end of the current *Apollo* program.

Despite the successful rendezvous just accomplished, there are other areas of the space program in which the picture is not so cheerful. The neglect of big solids continues. This is difficult to appreciate in the light of a successful 260-inch firing by Aerojet-General, successful 156-inch firings by Thiokol and Lockheed, and successful 120-inch performance as United Technology's part of the *Titan III-C* vehicle. With the Russians pressing hard on development of solid technology, this neglect is criminal.

It is compounded by the continued down-grading by the Dept. of Defense of Soviet solid missile development. We have moved from solid missiles to the beginnings of solid space boosters—and stopped. Without further impetus, the Soviets will soon overtake us in an area where we once enjoyed a substantial lead.

A year ago, we also were lamenting a two-year lack of impetus on the *Manned Orbiting Laboratory* program, which kept receiving a go-ahead but somehow never did. The situation isn't much brighter. Contracts have been announced but one could wish for a great deal more enthusiasm for this project from Secretary McNamara and President Johnson.

OVERALL, HOWEVER, this has been a year of encouraging development. Equally important to future space programs as the *GT-6/7* missions were the space walks of cosmonaut Alexei Leonov and astronaut Edward White. The capability for extravehicular activity is as important to many future space missions as the accomplishment of rendezvous. Both have been proven out this year.

It was a year of accomplishment also in unmanned space exploration. *Ranger IX* returned the last and best photographs of that program before smashing into the Moon's surface on March 24. And on July 14, *Mariner IV* swept by Mars to return the first close-up photographs. The Soviets, meanwhile, failed on the same mission when *Zond II* stopped transmitting long before reaching the red planet.

Another encouraging note was the frank admission of this failure by Soviet scientists attending a Chicago meeting in May.

The industry itself, assailed early in the year by doom-shouters, weathered the storm with an astounding display of strength in the stock market. Our Missile/Space Index, with last January 1 as a base of 100, now stands above 185—a climb well ahead of other industrial stocks.

Vietnam remains an unmoving cloud on the horizon but this was the year, also, when the industry began to take a strong interest in the application of its advanced technology to other fields. Spurred by the interest of the State of California, it found promising new markets for its systems management and engineering. Oceanology appeared as another potential growth area where industry know-how is needed.

Peace, it is clear at the end of 1965, is no threat to the industry of advanced technology. And it is on that note that we at MISSILES AND ROCKETS want to wish all of you a Merry Christmas and a happy, peaceful New Year.

William J. Coughlin

When you have an AiResearch gas turbine in your lightweight generator set, you aren't alone.

Almost everyone else does, too.

Garrett-AiResearch turbines are the prime movers for the majority of lightweight gas turbine generator sets now in operation by the United States Air Force, Army, and Navy.

This is no surprise when you consider what AiResearch gas turbines offer: Pushbutton starting, automatic control, speed stability, mobility, design simplicity, and proved reliability. In addition, they have a high degree of commonality of parts among the many models offered.

The ready availability of our standard turbines lets generator set packagers meet short delivery schedules. As an added bonus, replacement parts are carried in government inventory, and AiResearch turbines have federal stock numbers to simplify logistic support.

AiResearch Model	KW Output (Military Rating)	Weight (Pounds)
GTP 30	10— 30	80
GTP 70	30— 60	225
GTP 85	60—125	275
GTP 331	125—200	250

Standard AiResearch models provide power for broad range of applications.

Send us your packaging and output requirements for a prompt engineering evaluation and quotation. Or, for specifications of standard models for military and industrial applications, write AiResearch Manufacturing Division, 402 S. 36th Street, Phoenix, Arizona 85034.

Garrett
***is* experience**

GARRETT

AiResearch Manufacturing Division
Phoenix, Arizona

Aircraft ground support unit A/M32A-60 uses AiResearch gas turbine to produce AC and DC power and compressed air. Units were designed and produced by Wolverine Diesel, additional units produced by Libby Welding.

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Why Vector for MOL telemetry?

Proved competence in microtelemetry.

Vector pioneered in microtelemetry with the world's smallest production-model VCO — only .109 cubic inch, shock tested in excess of 20,000 G's.

Produced by the most advanced microelectronic circuit techniques, Vector components and systems have the high reliability characteristics which can come only from using *true* microcircuit design and production methods.

A family of multiplexers and A to D converters already exists. Vector also has design experience in signal conditioners, processors, synchronizers and demultiplexers. From this firm base, Vector offers complete follow-through — from systems design to hardware production — with the highest possible reliability.

Vector telemetry components and systems are used on a wide variety of space projects, including Saturn, Gemini, and Apollo.

Existing, proved micro-hardware... system design and follow-through capability . . . experience — good reasons why Vector is uniquely qualified to fill MOL requirements for airborne and ground-based data acquisition, handling and processing systems.

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